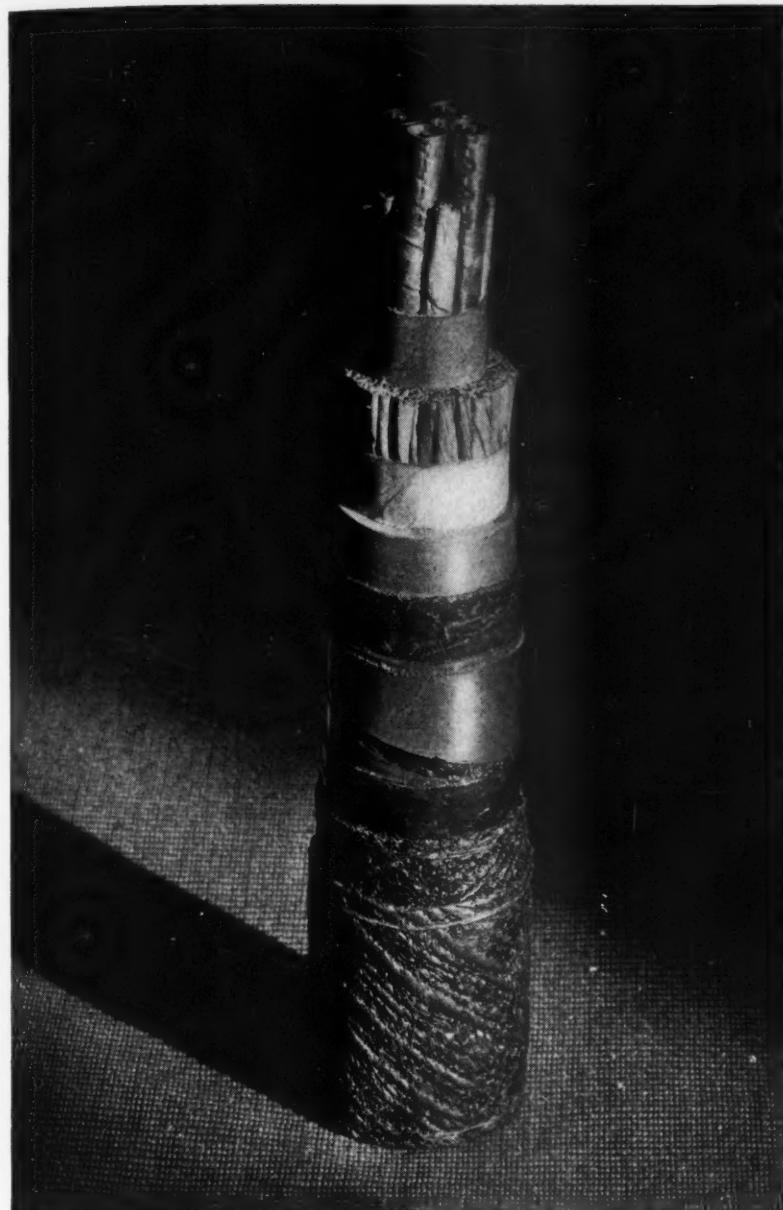


# BELL LABORATORIES RECORD



NOVEMBER  
1939

VOLUME XVIII  
NUMBER III

*Section of the Stevens Point-  
Minneapolis coaxial cable*



## Weather by Telephone

By W. BENNETT  
*Switching Development*

ON APRIL 8, the New York Telephone Company inaugurated a new service. In the metropolitan area, one can now dial WEather 6-1212 and hear the latest weather prediction, including the anticipated temperature, winds, and rain or snow conditions. The bulletins are based on direct teletype reports from the United States Weather Bureau; at present they are changed hourly between seven in the morning and eleven at night. In case of important changes special bulletins may also be given. All the equipment used for this service is installed in the West Fiftieth Street Central Office building, and weather-announcing trunks are run to all the central offices in Manhattan, while other parts of the metropolitan area reach the announcing bureau through subcenters or tandem offices.

Unlike the time-announcing system, in which a special operator makes each announcement herself, the weather system makes use of a tape recorder. Machines of this type have been used for a number of applications as already described in the RECORD.\* The machine used for the weather announcements is described in an accompanying article.† Three of these machines are employed; the announcement is put on two of them, one in service and one as a stand-by, while the third is available for the new announcement when it comes in from the weather bureau. The third machine is also available during maintenance on the other machines.

These three machines, together with all control and trunk circuits, are mounted on a set of bays on the third

\*June, 1933, p. 308; Mar., 1935, p. 200; Sept., 1937, p. 2. †Page 70, this issue.

floor of the building, but control of the system is concentrated in a small desk-mounted turret in a sound-proof room just off the information bureau on the thirteenth floor. The photograph at the head of the article shows the interior of this room and one of the special operators preparing to put a new announcement on the tape. At the right is the teletypewriter over which the announcements come from the weather bureau; in front of the operator is the control turret and the microphone with which she records the bulletin on the tape. A set of headphones is provided with which she listens to the announcement immediately after recording. The operator does this to make sure it is correct and of the proper volume.

The method of operation can be followed with the help of the simplified schematic of Figure 1, and the photograph of the front of the control cabinet in Figure 2. Each machine has allotted to it two keys and three lamps on the front of the cabinet, which also carries several other keys, lamps, and jacks used for the system as a whole. The lighted "in service" lamp shows which machine is in use.

To record a new bulletin, the operator moves the fourth key from the left in the bottom row up to the erase position and holds it there for about thirty seconds as timed by the electric clock. This starts the other two machines and energizes their erasing magnets to remove the previous records. She then operates the same key

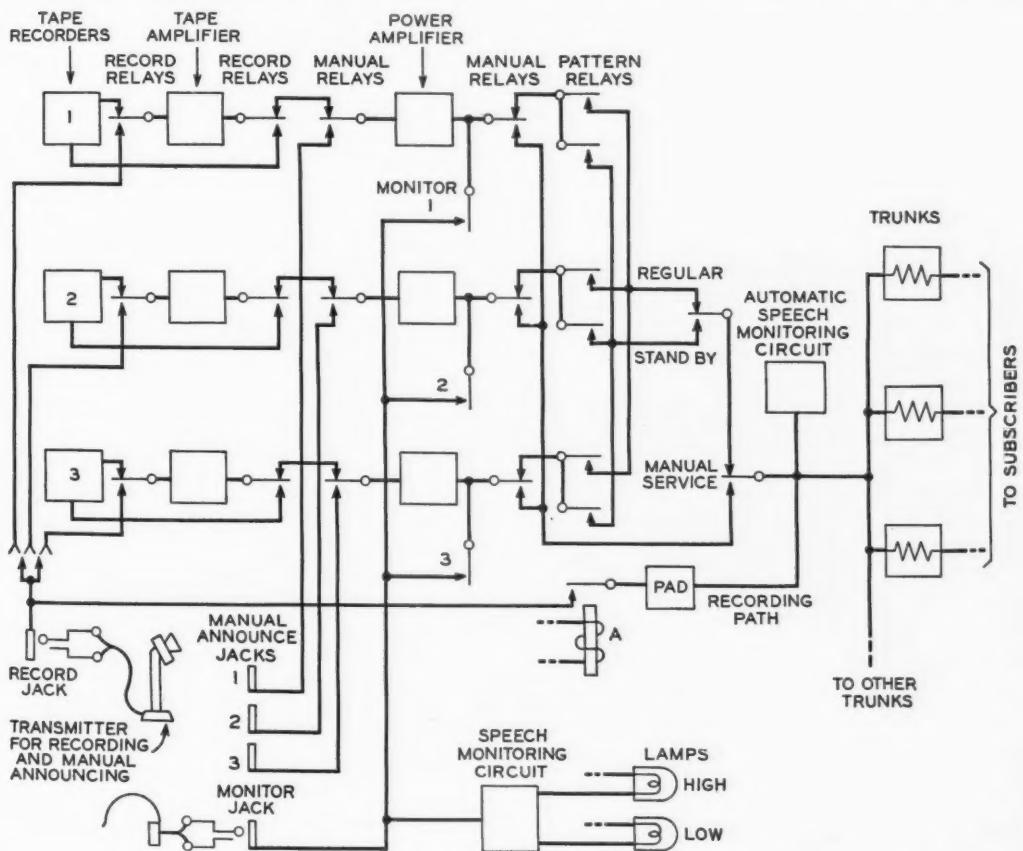


Fig. 1—Simplified schematic of the main transmission paths of the announcing system

November 1939



Fig. 2—Front view of control turret

to the down, or record, position and makes her announcement into the microphone. Operation of the key has actuated the "record" relay of each of the two machines not in use to the down position, as indicated in Figure 1, and established a path from the microphone through the "tape" amplifiers. After completing the announcement she restores this key to the normal position. She then operates the "monitor" keys, successively for the two machines, and listens to the announcement. If it is too high or low in volume one or the other of the two lamps above the lower row of keys will light. If unsatisfactory the announcement will be erased by the operator and re-recorded; but if neither lamp lights, and if the record is correct, she will operate the "cut-in-service" key—the third from the left. This cuts out of service the machine with the previous announcement, cuts one of the machines with the new announcement into service, and arranges for the other to be used as a stand-by. Lamps in the squares on the front of the panel light auto-

matically as the machines are put in a "recording" or "service" condition, so that the operator has an indication at all times as to how the various machines are being employed. After the system has been put in service with a new recording, it requires no more attention until a new announcement is to be recorded.

From Figure 1 it may be seen that besides the "tape" amplifier, there is a sec-

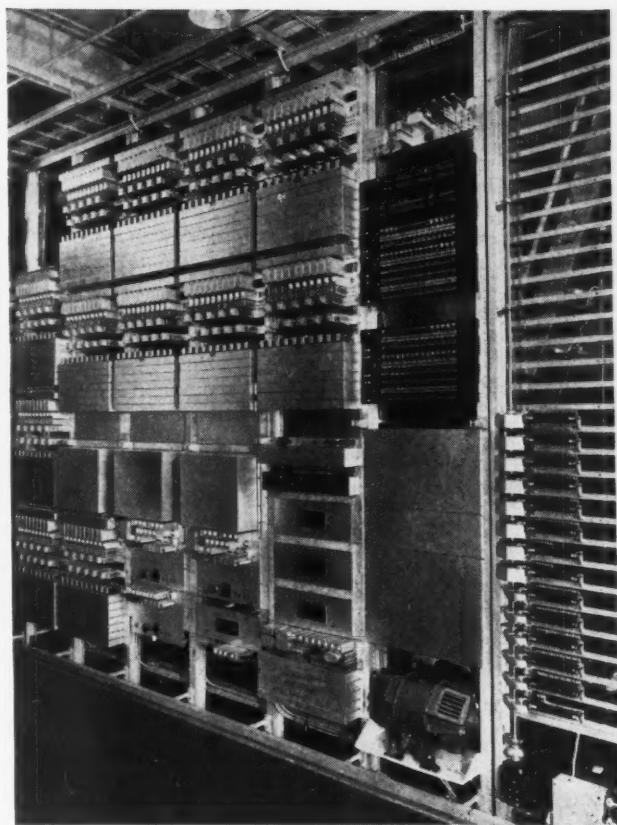
ond amplifier for each machine in the reproducing circuit only. These raise the level of the reproduced speech for transmission over the trunks and are known as power amplifiers. Their output is branched through two "pattern" relays, one along a "regular" path and one along a "stand-by" path. These are controlled by an automatic circuit associated with the "cut-in-service" key on the turret, and select the machines for use in a definite rotation, so that each machine is in service, held as a stand-by, and out of service the same amount of time, except for the occasional maintenance that is required.

On the output circuit, just ahead of the trunks, is an automatic speech monitoring circuit. Every thirty seconds the circuit monitors the announcement to make sure that speech is being transmitted and that it is of the correct volume. If it does not find conditions satisfactory, it automatically transfers the load to the stand-by machine and gives an alarm to attract the attention of the maintenance force. This speech-monitoring equip-

ment is the same as that used by the operator in monitoring a new recording, and may be interchanged with it in event of trouble.

In the remote eventuality that all machines should be out of service at the same time, the operator can give the announcement herself by plugging her transmitter into one of the three jacks in the lower right-hand corner of the turret. This automatically operates one pair of the "manual relays" and also the "manual service" relay, which establishes a path directly from her microphone to the outgoing trunks. As soon as one or more of the machines is ready for service, a recording will be made by way of the contacts of relay A without the necessity of plugging into the recording jack. Normal service may then be restored in the usual manner.

The equipment arrangement is shown in Figure 3. The three tape machines are under the rectangular covers on the three bays near the left center of the photograph. The three "tape" amplifiers are immediately above them, and the three "power" amplifiers are mounted one above the other on the bay at the right. Below the two right-hand tape machines are the two automatic speech monitors. The rest of the control circuit is mounted below the "power" amplifiers. Outgoing trunks are arranged in groups of ten; two of such groups are above each of the "tape" amplifiers.



*Fig. 3—Equipment bays for the weather-announcing installation in New York City*

The tape machines and both types of amplifiers operate on commercial 110-volt a-c power, but a motor-generator is provided—second bay from the right—which in case of failure of the commercial source will operate from the office battery and provide the needed a-c power. The upper part of this bay carries fuses for the various circuits. The right-hand bay carries interrupters used to disconnect calling lines automatically after a period varying from one to six minutes. These are provided to prevent trunks from being held busy by a failure to hang up.



## Weather-Announcing Tape Machine

By R. A. CUSHMAN  
*Commercial Products Development*

**A** WEATHER-ANNOUNCING machine is now installed at the West Fiftieth Street central-office building of the New York Telephone Company. With this machine, telephone subscribers throughout greater New York may receive authoritative forecasts of weather conditions. Information for these announcements is supplied hourly between seven A.M. and eleven P.M. by the local office of the United States Weather Bureau over a direct teletype connection.

Magnetic tape recording is well suited to services of this type where it is necessary to change the recorded message frequently and where permanent preservation of the record is of no importance. The record is made by producing in a moving steel tape\* of high retentivity a magnetic pattern corresponding to the voice current coming from the microphone circuit. This pattern remains in the tape and can be "picked up" electrically many thousands of times until erased, which is done by saturating the tape with a heavy magnetic field. The entire process of erasing, recording a new message, and reproducing is controlled by a few keys at the operating turret. No experience or technique is required to obtain faithful reproduction of the announcement, and since the steel tape may be used again and again indefinitely, there is no continuing expense for record material and there is no processing cost involved.

\*RECORD, Sept., 1937, p. 2.

Three of these machines are mounted, each with its associated amplifier, on the relay-rack bays that carry the apparatus for control and distribution of the service. The tape machine employs slightly over forty feet of tape wound on three accurately machined brass drums. The two ends of the tape are electrically welded to form a single tape loop, which is driven at a very uniform velocity. About twenty-five seconds is required for the passage of the tape between the recording and reproducing pole pieces. Figure 1 shows the general arrangement of the machine, which is mounted on a steel panel bolted to the relay rack. The brass drums for holding the tape are arranged in a triangle, as shown, with their front ends supported by the triangular plate attached by channel struts to the main panel. The drum shafts run in large wick-oiled bearings. Variations in the length of the tape due to temperature changes are compensated by a spring idler, which appears behind the circular hole in the front plate and maintains a light but uniform tension in the tape. Certain improvements in fundamental design of the equipment, which have had notable effect on the quality of the recording, were contributed by D. E. Wooldridge of the Research Department.

A unique method was developed for storing the long tape loops in a small space. The design employs combs, consisting of spaced washers, for maintaining the position of the tape

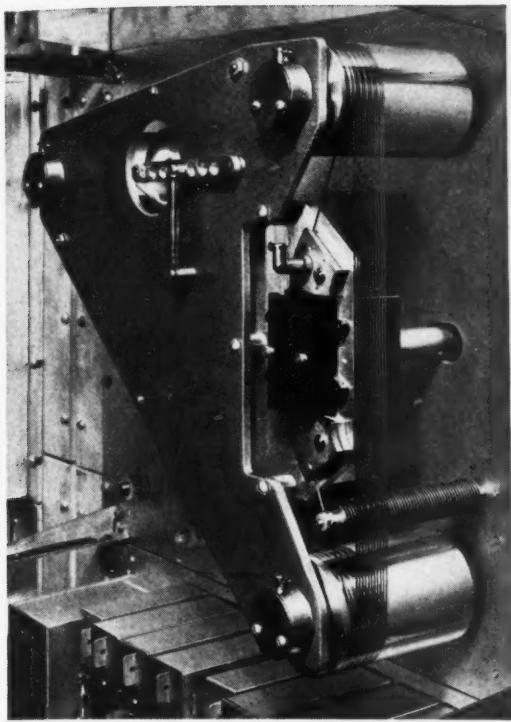


Fig. 1—Front view of tape machine with cover removed

on the drums; and it requires no cross-over idlers. One of the combs is visible just above the lower drum in Figure 1. (Space is provided for a tape loop of three times the present length if a longer message appears desirable in the future.) The drums above and below the pole-piece unit are driven by the tape. The drum whose bearing appears at the extreme left of the figure is driven by the large pulley which may be seen in Figure 2, showing the back of the main panel. A small split-phase induction motor is mounted on a hinged support so that its weight maintains proper tension in the

driving belt. To maintain the extremely constant speed required in all forms of satisfactory recording apparatus, a flywheel is attached to the motor shaft, which runs at 1725 rpm.

On the rear of the panel there is also a condenser used with the split-phase motor, and beneath it, a relay to permit control of the motor (110-volt, 60-cycle) from the 48-volt d-c control circuits of the system. Two covers have been removed for the view of Figure 2; the one on the right protects the pulley and the belt from accidental contact, and the one on the left covers the exposed a-c terminals on the condenser and relay. The plug, shown in the foreground, is used to supply a-c from a standard conduit outlet. The terminal board on the left provides connection to the control circuits and to the pole pieces. The pole-piece circuits are fed, by the cable shown, through the panel to a plug and jack which facilitates the removal of the pole-piece unit for any necessary servicing.

The amplifier, shown in Figure 3, is mounted immediately above the machine on the rack. Since it is used both in recording a message and in reproducing it, input and output relays are

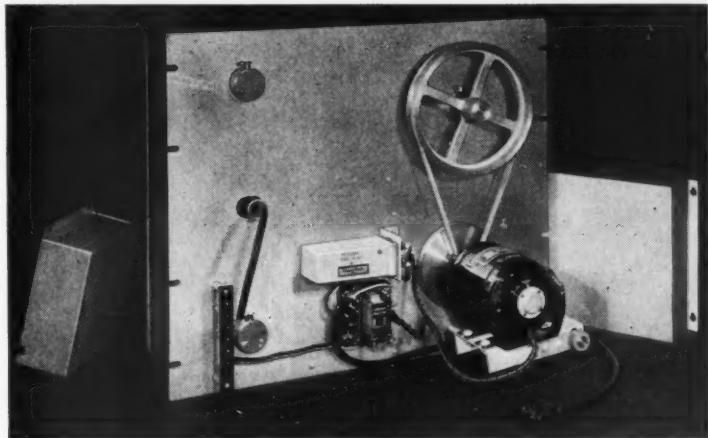
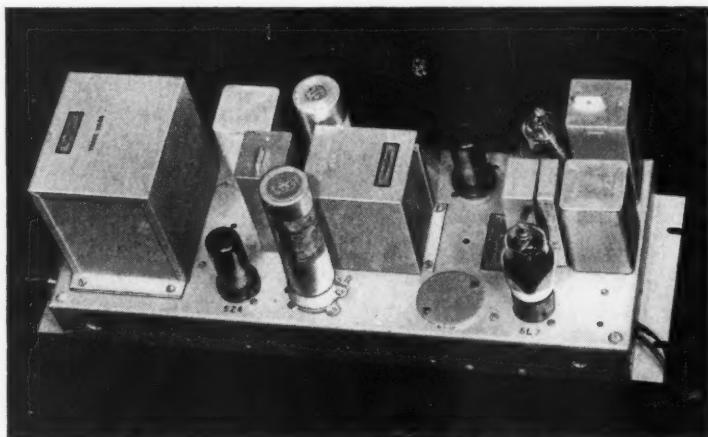


Fig. 2—Rear view of machine showing driving arrangement

provided which during recording enable the low-level microphone current to be amplified to the correct level and supplied to the recording pole pieces. The self-contained rectifier which supplies d-c power for the tubes of the amplifier also supplies the erasing and biasing currents for the pole pieces as switched by these relays. In reproducing, the relays reconnect the amplifier to amplify the relatively weak potentials obtained by the pole pieces from the magnetic patterns on the tape to a sufficient level for feeding the power amplifiers

associated with the distribution system. The amplifier—like the tape machine—requires a 110-volt, 60-cycle a-c power supply. Separate controls are provided for adjusting recording and reproducing levels.

Since the machines are mounted on racks containing amplifiers and other vacuum-tube apparatus, it was essential that vibration and acoustic noise be reduced to low levels. This has been accomplished by mounting the motor assembly on rubber pads. As a result, the machines have proved to be unusually quiet in operation.



*Fig. 3—Recording and reproducing amplifier used with the tape machine for the weather-announcing system*



## An Artificial Mastoid for Audiphone Measurements

By M. S. HAWLEY

*Transmission Instruments Engineering*

**I**N DEVELOPING bone-conduction audiphone receivers, it is necessary to make frequent measurements of response-frequency characteristics. The time required to develop a receiver is largely dependent on the speed with which these tests can be made. Simple and easy tests of the receivers after manufacture are likewise highly desirable. The obvious way of making response measurements would be to place the receiver on someone's head, and then obtain the response either by a listening test or by measuring the vibrational velocity of the receiver, which can be correlated to the auditory response. Either of these methods requires two people, however, and the listening test is further handicapped by being laborious and difficult to duplicate because of variations in hearing acuity of different people and of the same person from time to time. Some simple testing procedure in which these types of variations would not occur was highly desirable.

Because of the inherent difficulties of listening tests, measurements of the vibrational velocity of the

receiver at various frequencies seemed the preferable method of test, if some satisfactory way of loading the receiver could be found. The load on the receiver during the test has a definite effect on the response obtained. If a golf ball, for example, is dropped on a hard cement sidewalk it will bounce freely up again, nearly the distance it was allowed to fall, but if it is dropped on a soft wood sidewalk or on an asphalt road softened by the sun, it will scarcely bounce at all. The response of the ball, in other words, depends on the characteristics of the material it strikes. In a similar manner the response of a bone-conduction receiver depends on the

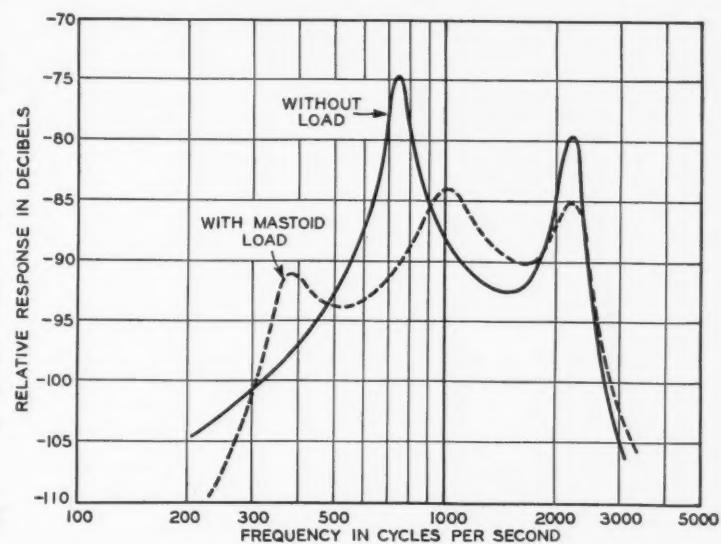


Fig. 1—Relative response of an experimental bone-conduction receiver with and without the mastoid load

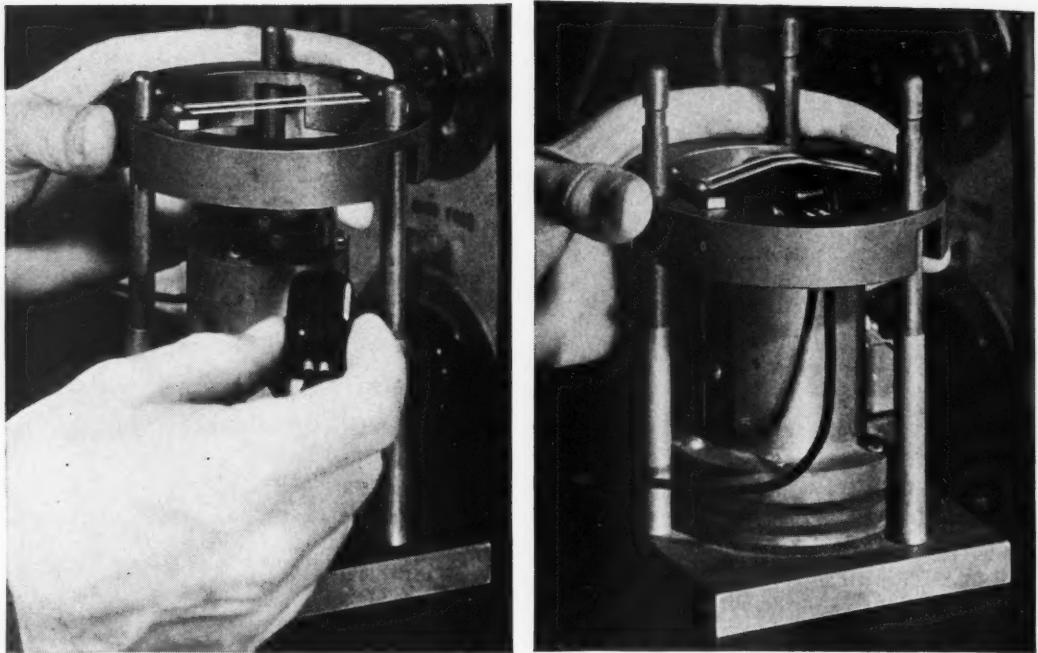


Fig. 2—Left, the artificial mastoid with weight raised ready for the insertion of the receiver; right, the artificial mastoid with receiver in place

load against which it works, which is supplied by the surface it rests on; its response when laid on a desk, for example, will be different from its response when pressed against the mastoid bone, which is the usual way of wearing it. The effect of the load on the receiver is indicated by Figure 1, which shows the relative response of an experimental receiver measured both with and without the mastoid load.

To provide a method of measuring the response of bone-conduction receivers under the correct mastoid load but without the inconvenience and inherent irregularities that would result from measurements taken on a human mastoid, an artificial mastoid was developed in the Laboratories. The impedance offered by the mastoid to a bone-conduction receiver was measured on a number of people, and then a rubber block was designed that presented to a receiver placed upon it approximately the same im-

pedance as the average human mastoid. The arrangement is shown in Figure 3. The annular weight 3 of Figure 3, working through the rubber bands 2, holds the receiver against the rubber block 1. The weight of this ring is equal to the force which the headband furnishes in normal use.

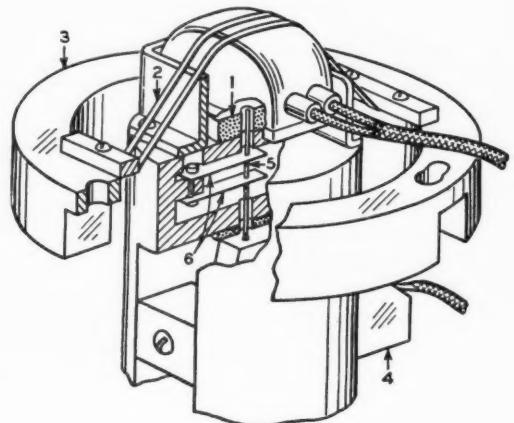


Fig. 3—Diagrammatic drawing of the artificial mastoid indicating operating parts

The vibrational velocity of the receiver is measured by a vertical type phonograph reproducer, 4 in the diagram, which is connected to the receiver through the rod 5 supported by the springs 6. These latter merely guide the rod and carry its weight; they have no appreciable effect on the response.

Velocity measurements made on the artificial mastoid may be changed to acoustic response if desired by use of the curve shown in Figure 4, which is plotted from data gathered by the Laboratories. This curve shows, for the usual frequency range, the velocity of the bone-conduction receiver, relative to a velocity

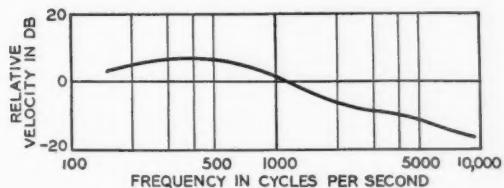


Fig. 4—Velocity of bone-conduction receiver required to produce a hearing sensation equivalent to one bar pressure in an open sound field

of one centimeter per second, that is required to produce a hearing sensation equivalent to one bar pressure in an open sound field.

Since the artificial mastoid is based on average values of mastoid impedance, there may be slight variations in the results obtained with it and with some particular subject. The possible deviations are indicated by

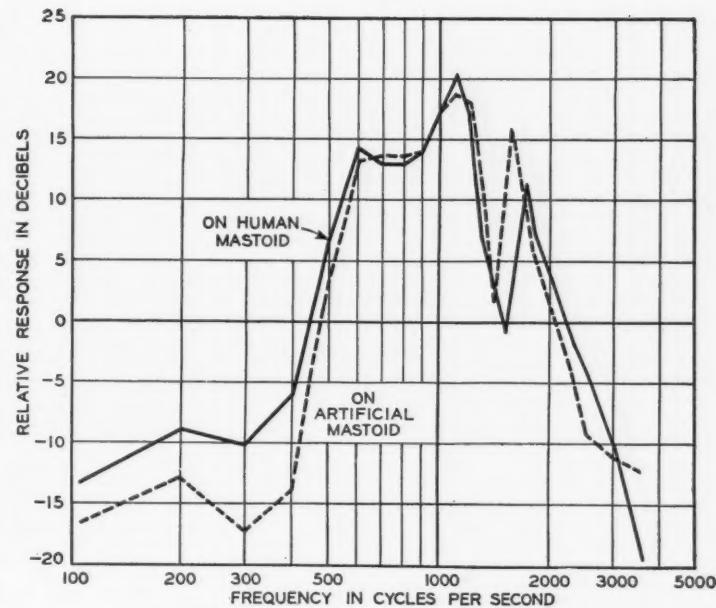
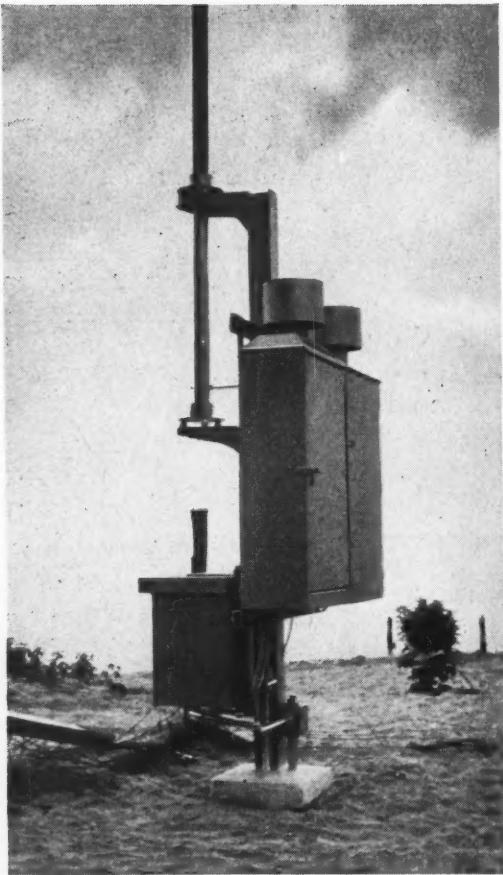


Fig. 5—Relative response of an experimental bone-conduction receiver on artificial mastoid and in actual use

Figure 5, which shows a response obtained with the artificial mastoid and with one particular subject. There is a slight departure evident at the very low frequencies, but over the major part of the frequency range, the results are in close agreement, and are accurate enough for all practical purposes. Measurements on the same instruments made over a period of a year have shown very good correlation. Eventually, the rubber pad will age and change in impedance characteristics. The replacement of the old pad by a new one is a simple matter, however, so that the aging of the rubber pad should not be of considerable consequence.

The artificial mastoid may be used in making other tests on receivers in which it is desired that the receiver be coupled to an impedance load equal to that of the head. Such tests include electrical impedance measurements, rattle tests, and non-linear distortion measurements.



## A Remotely Controlled Radio Receiver

By C. B. MCKENNIE  
*Radio Development*

located at Setauket, Sands Point; at Venetian Shores near Babylon, Long Island; and at Rosebank on Staten Island. Since attended telephone offices are not usually found at the isolated points selected for the receiver sites, the receivers have been designed to be mounted on telephone poles, and to operate for long periods without attention.

Arrangements have been provided for controlling the operation of the receiver over a single telephone line. The control circuit, which is described in an accompanying article,\* controls two oscillators used for testing; and it gives an alarm when the receiver automatically switches to or from the emergency power supply. It also provides for the codan—a carrier-operated device used to disable the receiver when no carrier is being received—to signal the operator when carrier comes in, and to transfer the talking circuit between transmitter and receiver during a conversation.

When used for remote control, this new receiver, known as the 23AB, is mounted in a weatherproof cabinet together with the power supply and relay equipment essential for its operation. This cabinet is usually mounted on a pole, which also supports the antenna. The installation at Sands Point, with two pole-mounted receivers, is shown in the photograph

\*Page 91, this issue.

**I**N COASTAL radio-telephone circuits, the shore transmitter is in frequent use, and equipment of moderately high power is justified. Any individual ship transmitter, however, is used far less frequently; the owner is naturally interested in keeping down its space requirements and its cost; and so ship transmitters of only a few watts output are common. To provide good reception from the low-power ship transmitters, which in addition usually have antennas of low efficiency because of the small size of the vessel, the shore receivers should be located in residential or country districts and should be spaced at short enough intervals to permit one always to be within close range. At the New York station, for example, is a single 400-watt transmitter, but receivers are

at the head of this article. The complete equipment is known as the 223A Radio-Telephone Equipment, and includes—besides the receiver proper—a dynamotor panel, a control panel, a test oscillator panel, and a battery with trickle charger, which is used in event of failure of the commercial a-c supply normally employed. This emergency battery and charger is mounted in a separate weatherproof box shown in Figure 1.

The main cabinet with door open and dust covers removed is shown in Figure 2. The receiver, dynamotor, and relay equipment are mounted on 19-inch panels which fasten to a supporting frame similar to a short section of relay rack. The frame is hinged, slightly off center, at the top and bottom, and after removing two screws it may be rotated. Removing the rear covers gives easy access to all the wiring and equipment on the back.

A 110-volt commercial supply is brought to a switch to supply the receiver under normal conditions.

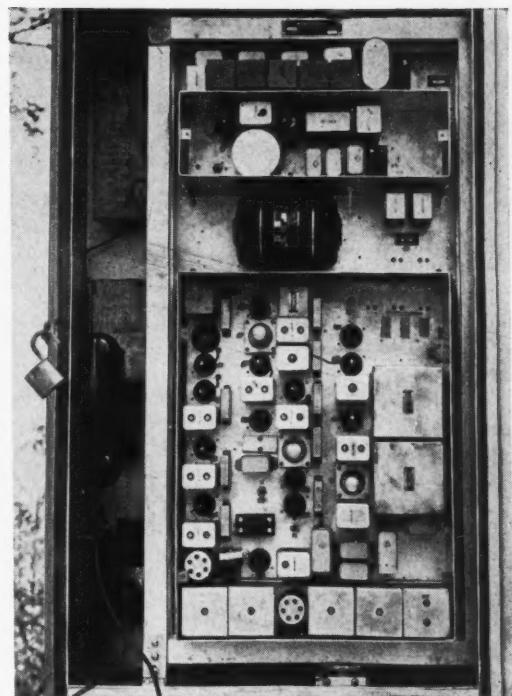


Fig. 2—Main receiver cabinet

From this switch a connection runs to the battery box where a charger keeps the battery fully charged under normal conditions. In the two boxes above the power switch are filters for the power and telephone lines to prevent radio-frequency disturbances picked up on the lines from interfering with the radio receiver.

The receiver is arranged so that when the a-c supply fails, the equipment is automatically shifted to the battery by relays. The dynamotor is then driven by the battery and furnishes the high-voltage supply, while the filaments and crystal heaters are transferred directly to the battery. When this occurs, a signal is sent over the connecting line to the control office to warn of the failure. When the sup-

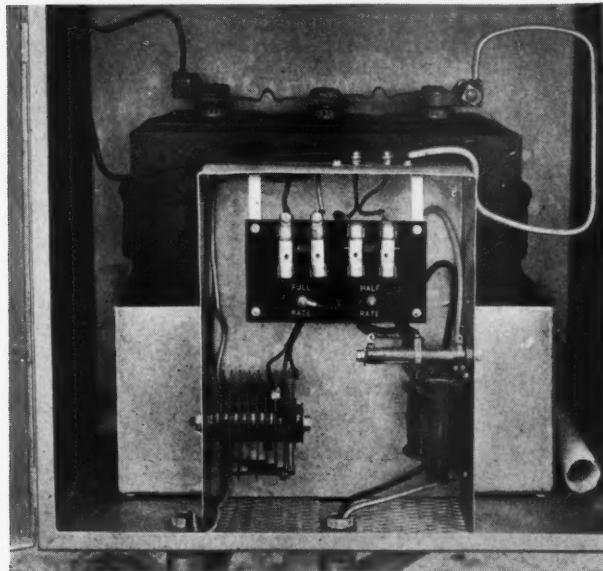


Fig. 1—A 6-volt storage battery, trickle charged, for use in case of failure of the a-c supply

ply comes on again, the equipment is automatically transferred back to it, and a similar signal is sent to the control office. It is thus possible to keep a record of the duration of the power interruptions so that steps may be taken to keep the set operating if a power failure is protracted.

The circuit of the receiver is indicated by the block schematic along the upper line of Figure 3. Three tuned circuits are provided ahead of the first radio-frequency amplifier to provide high selectivity, and two other tuned circuits are connected between the amplifier and the first detector. The overall selectivity characteristic is shown in Figure 4. These curves show the value of an undesired signal in microvolts that will be 20 db below the desired signal at various frequency separations from the desired frequency.

In the intermediate-frequency section of the circuit, double-tuned filters are connected between the first detector and the first intermediate-frequency amplifier, between the first and second intermediate-frequency amplifiers, and at both sides of the

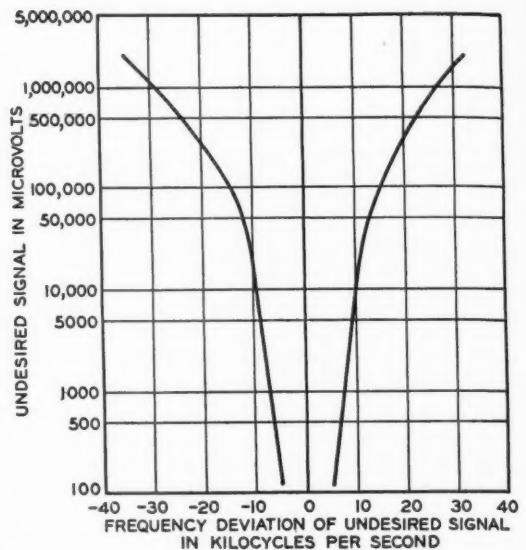


Fig. 4—Radio-frequency selectivity of the 23AB radio receiver

peak limiter. The detector-amplifier for the automatic volume control is connected at the input of the audio detector. A level-control potentiometer is inserted between the detector-audio-amplifier and the output tube. Intermediate and audio-frequency characteristics of the receiver are shown in Figures 5 and 6. The automatic volume control limits the

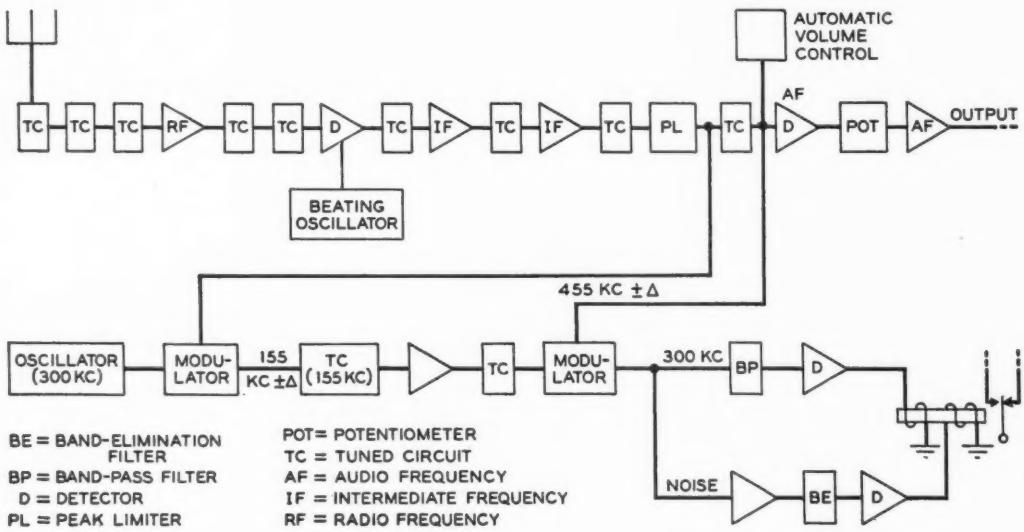


Fig. 3—Block schematic of receiver, above; and codan, below

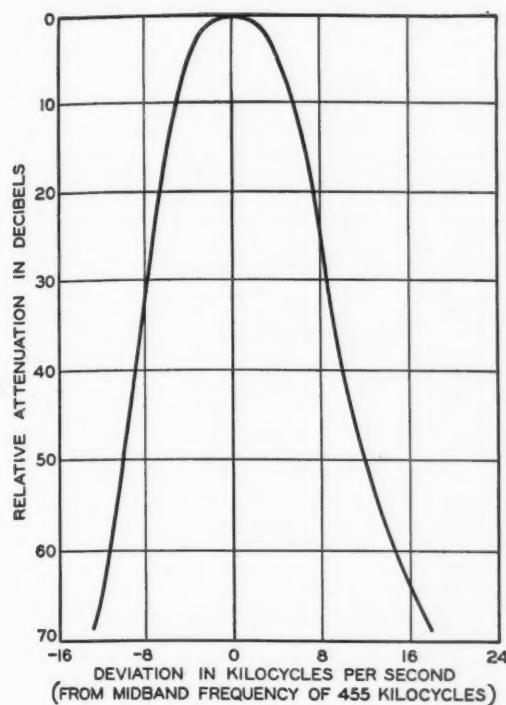


Fig. 5—Intermediate-frequency characteristic of the 23AB radio receiver

change in output for a 100-db change in input to about 5 db, so that a wide variation in signal input has a negligible effect on output level.

In its simplest form a codan employs a relay adjusted to operate when carrier is on, and not to operate on noise alone. In this simple form, however, frequent readjustment is necessary since both carrier and noise vary in level. If such adjustments are not made, an increase in noise level may actuate the relay without any carrier present, or a decrease in carrier level may result in a failure to operate. Since the 23AB receivers are to be unattended, a codan was desired that would be operated only by the carrier and that would always operate whenever the noise level permitted the

circuit to be used for commercial service. Both of these requirements indicated the necessity of a narrow-band filter to pass the carrier but to reject the noise. Since, however, ship transmitters are not under the supervision of a shore station, their carrier frequencies will vary somewhat, and means must be found for eliminating any variation before the current enters the filter. This was done, in effect, by using the incoming carrier to control the output from a local oscillator as described below.

In the schematic of Figure 3 the receiver is seen to be of the double-detection type. The beating oscillator is set to such a value that the intermediate frequency is 455 kc, if the ship station's carrier is at its assigned value. Some of this 455-kc current is combined with a 300-kc current generated in the codan, and the lower sideband at 155 kc is selected by a filter. After amplification, this frequency is modulated with the 455-kc current and the lower sideband, at 300 kc, taken off. It will be observed that any variation in the frequency of the ship's carrier will appear in the intermediate frequency; but since the intermediate frequency is first added to and then subtracted from the 300 kilocycles, any variations cancel out, and the frequency applied to the

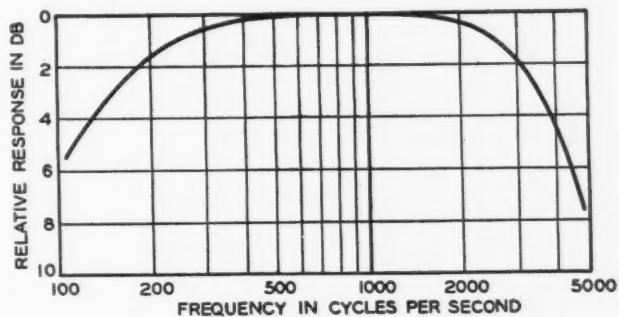
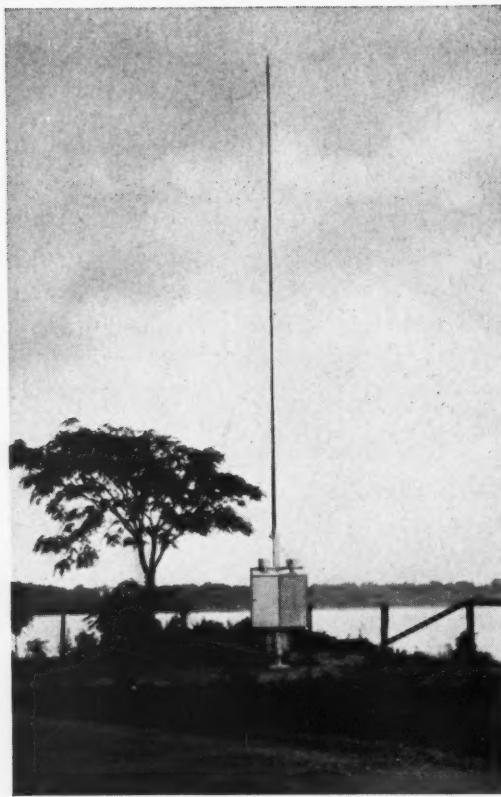


Fig. 6—Audio characteristics of the 23AB radio receiver for remotely controlled service



*Fig. 7—Installation at Sands Point*

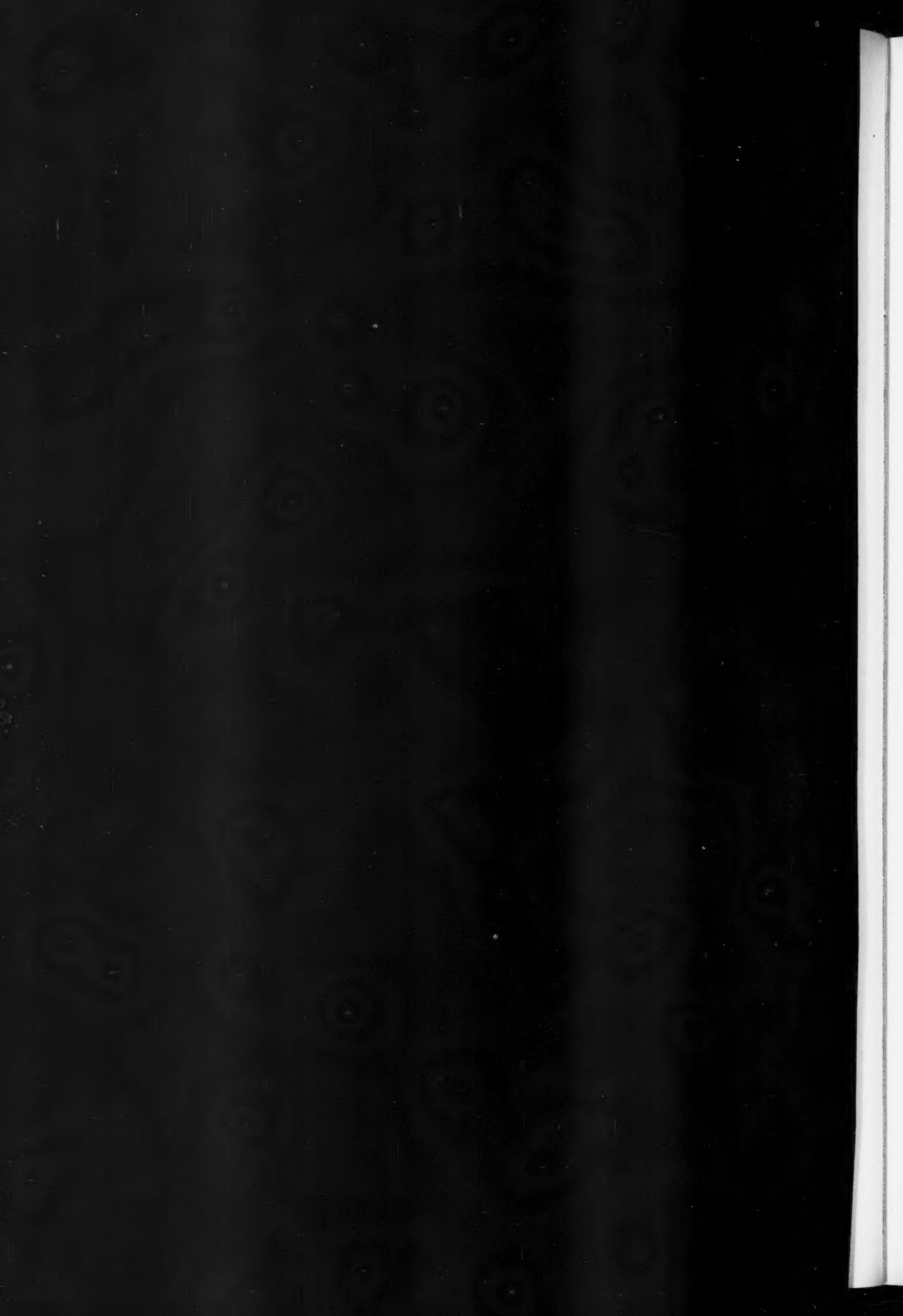
narrow band filter is exactly 300 kc. Amplitude of the 300-kc current is substantially proportional to that of the ship's carrier.

To make the codan operate when the carrier exceeds the noise by a

fixed amount, the small amount of noise which comes through with the 300 kc is separated from it by a band-elimination filter, rectified, and used to bias a relay against the pull of the rectified 300-kc current. When no carrier is being received, the relay is held operated in one direction by the rectified noise output and disables the audio output of the receiver. When the carrier comes on, the energy from the narrow band in the second winding opposes the effect of the noise current in the first winding, releases the relay, and removes a short circuit from the receiver output.

Actual operating experience in a trial installation has shown that the performance of the receiver is highly satisfactory. Among advantages noted are the elimination of high-level noise from telephone cables and from the monitoring loudspeaker; appearance of a lamp signal at the toll board when a ship calls; and acceptance of calls from more and more distant stations as the noise level falls. No adjustment is required for a wide range of noise conditions and reliable operation of the codan is obtained even from radio circuits that are normally too noisy for commercial service.





## Address by Walter S. Gifford

### *to the General Assembly of Telephone Pioneers of America*

ACH of us telephone pioneers has devoted at least twenty-one years to the task of enabling our fellow citizens, however far apart, to talk instantly with each other, any time of day or night, and, in recent years, with practically anyone anywhere in the world. It seems to me, therefore, that on this occasion it is fitting for us to take pride in our achievements and consider our hopes for the future. We know that individually and collectively we may have made mistakes but whatever they have been the record of achievement speaks for itself and we have every reason to be proud of it.

These are troublous times in the world. There is much to concern us individually about conditions in our own country, and the international situation is fraught with dangerous potentialities for all of us. As citizens, we have grave duties that we share with our fellows outside as well as inside the business, but usually most of us, I have always felt, can make the greatest contribution to the general welfare by doing our own main job well. For us, this main job has been the development and operation of a great system of communications. In its growth and improvement we have pioneered in many matters of social importance besides the technical development of facilities for inter-communication by speech. I do not mean to exclude the latter from the field of matters of social importance for it is obvious that it is of very great importance to mankind that today there are no earthly limits of distance to practically instantaneous conversation by telephone. The entire development of the telephone is so recent, within the lifetime of many present here tonight, that no one can appraise the real effect upon mankind of this removal of distance as a limitation to human speech. Besides this technical development in which we are recognized as having led the world, there are other achievements in which we have pioneered and which, in my opinion, have been of great importance to the general welfare of our country. By pioneering, I do not mean that we were necessarily the very first to blaze the trail but I do mean that we were, if not the first, among the first to set out on new paths. On their face, some of these undertakings are not especially interesting, but I believe they have had very great influence in important ways.

One example of this sort of pioneering is the depreciation accounting of the Bell System. It would be difficult to overestimate the effect of the adoption years ago, shortly after I started in the business, of a fixed depreciation charge to

expenses which had to be charged in good times and bad before arriving at net earnings available for dividends. This has been of great importance in the maintenance of the financial integrity of the Bell System and in the rapidity with which new and improved methods have been adopted and obsolete plant has been abandoned. Thus it is interesting to note how what seems to be mere bookkeeping can be of vital consequence not only to investors but to telephone users.

We pioneered in the adoption of the Benefit Plan over twenty-six years ago. That was a step far out in front in those days. It provided for definite payments to employees in case of accident or sickness and to dependents of employees in case of death, and for pensions after retirement. Remember that this was over twenty-six years ago, when even Accident Compensation Insurance, now adopted by nearly all the states, was just getting under way. Again some twelve years ago the Bell System pioneered in the adoption of the Accrual Plan for providing for pensions as against the Pay-As-You-Go Plan. The result is that there is now in the hands of Trustees, held solely for pension purposes, some \$265,000,000. As in depreciation accounting, this pension accrual item of expense must be provided for before arriving at net earnings for dividends. This pension accounting has not been in effect as long as the depreciation accounting, but, in my opinion, in addition to its importance to the welfare of the employee, it ranks with depreciation accounting in its importance to the stockholder and the telephone user.

Practically from the very start of the telephone business, the Bell System has had its own manufacturing department. This was unusual and forward-looking. It has meant that the Bell System has done its own pioneering in the development of physical things and has manufactured what was wanted instead of relying for progress entirely on such developments as manufacturers, over which it had no control, might produce. Moreover, whatever profits have resulted from the manufacture of equipment have gone to help pay to investors in the business the return necessary to keep the enterprise financially sound. The Bell System's central purchasing and supply department performs a function of great benefit to all. Since its establishment some twenty-five years ago, many other enterprises, including governmental agencies, have set up similar centralized purchasing departments. A word should be said in passing of the immense value in time of emergency of this

centralization of manufacturing and supply. No better illustration could be had than that of the hurricane disaster of the fall of 1938 in the northeastern section of the United States.

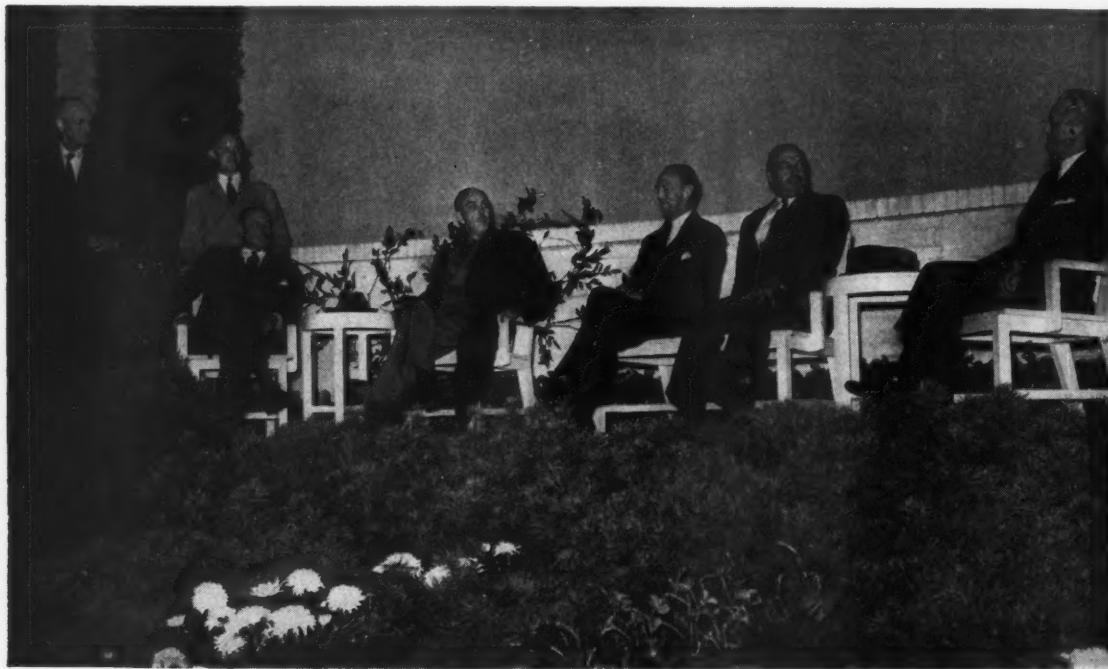
We pioneered again in having research and development carried on in a central organization. This insured progress in spite of the fact that competition in the usual sense of the word—such competition which is assumed to be essential to progress—has been largely absent. In many ways this organization of scientists, engineers, accountants and experts in management and operating methods has been and remains unique. It has been recognized as a most important factor in the success of the telephone business from the standpoint of those employed in it, those who have invested in it and the public who use the telephone. Commissioner Eastman of the Interstate Commerce Commission, a few years ago said that he would like to see a central scientific, engineering and economic research department acting for all the railroads along lines similar to that of the Bell System.

It is not without importance, either, that we were pioneers in that form of advertising which has come to be known as "institutional" advertising and that this advertising has been unin-

terrupted since its inception in 1908. In such advertising, it has been natural to emphasize the contributions to the service of the System's men and women and you are all familiar with the advertisements, "Weavers of Speech," featuring the operator, and "The Spirit of Service," portraying the lineman working in a blizzard.

Also, I believe it is fair to say that we were pioneers in courtesy in business. The "voice with the smile," the "number, please," and the spirit of service that inspires all telephone men and women have been notable characteristics of the telephone business for decades. It is, in fact, important not only to the satisfaction of customers but in its reaction on the employee himself or herself. It would be interesting if one could evaluate the effect of the habit of being courteous under all conditions on the character, self-restraint, and likeableness of the individual and on the satisfaction and pleasure he gets from his job. But it is only men and women of high quality and genuine devotion who can establish and maintain the reputation which I believe the System has for courteous and outstanding service.

One hears a good deal about the recognition on the part of business—big business especially—of its social obligations. Apparently for many,



*During the recent Bell System Public Relations Conference, held in New York and Princeton during the week of September 18, the group visited the Bell System Exhibit at the New York World's Fair. Here, participating in the Audition Demonstration, we find (left to right) John Mills of the Laboratories; Fred Leary, demonstration interlocutor; V. E. Cooley, New York Telephone Company; M. E. Bennett, Mountain States Telephone and Telegraph Company; K. T. Rood and J. O. Perrine, American Telephone and Telegraph Company; and J. T. Sheafor, Michigan Bell Telephone Company*

this seems a new idea. We know that in our business such recognition of social obligations goes back many years. At a time when other businesses were booming, stock split-ups and extra dividends were almost the order of the day, we stated definitely for the Bell System that either earnings in excess of those needed to assure the financial integrity of the business must be spent for the enlargement and improvement of the service or the rates must be reduced. That obligation which includes fair treatment of employees has been and will continue to be strictly lived up to. The interrelation of the employee, the stockholder and the public and the rights of each have long been recognized by us, and we are, in my opinion, justified in feeling we were pioneers in recognizing the social responsibilities of business in a democracy.

There are others matters in which we in the telephone business have pioneered and blazed the trail. Time has permitted me to cover only some of them. I realize, in claiming for our industry all that I do, I have in most instances stressed what has been done in the Bell System which, of course, is by no means the entire industry. I feel, however, that we are all part of the same family and what one member of the family does, the entire family is concerned with and if it is creditable may properly take pride in.

For the past ten years we have had a great depression in this country; in extent of unemployment, in the relative decline in business volume, and in duration, the most severe in our history. It is true that public relief has kept millions fed, clothed, and housed and work has been found or made for millions of those who wanted to work but would otherwise have been unemployed. It is also true that, for the population as a whole, the material standard of living has been higher than that of most of the rest of the world, even in prosperous times. We should not lose sight of these facts but we must not minimize, either, the severity of the shock which the loss of their jobs and their savings brought to millions of our fellow citizens. Millions more, even those less directly affected, lost confidence in the future. The country's leaders cannot fail to recognize a challenge in this depression but neither these leaders nor the country as a whole should interpret it as evidence that the development of the country is finished, that progress is over. To do so would be absurd. We know better; we know that the pioneering in our country and in our particular field of telephone communication is still going on and will go on. I have faith, and I am sure all of you have faith that, in spite of the troubles which seem to beset us on all sides, the future holds even greater promise.

Those of us in this room represent the 44,459 members of the "Telephone Pioneers of

America." This number is about 12 per cent of all the employees in the telephone industry, including its manufacturing and research units. Ten years ago, our membership was but 16,700 and that number was only about 3 per cent of the industry's employees. With this large growth in membership has come a greatly increased opportunity to plan an influential, in fact a decisive, part in the maintenance and enhancement of the industry's ideals of outstanding service to the public. It is our belief and our pride that this reputation for service has become a tradition of the business, recognized by the nation. It is peculiarly the trust given to those who have spent the best part of their lives in the business and who have made it what it is, to preserve and carry forward that tradition.

Let us therefore dedicate ourselves to still greater achievements and let us encourage our younger associates who have not yet been with us long enough to qualify for membership in our great organization of "Telephone Pioneers." Let us encourage them to continue to pioneer and to keep up our record of leadership, not only in technical advances, but of leadership in creating and maintaining relationships between management and other employees, stockholders and the public that benefit not only the telephone business but the general welfare of our country.

#### BELL SYSTEM PUBLIC RELATIONS CONFERENCE

DURING THE WEEK of September 18 the Bell System Public Relations Conference was held in New York City and in Princeton, New Jersey. On September 19 the members of the conference visited the Laboratories where they first assembled in the auditorium. Following a talk and demonstration by Dr. Buckley, they went on a tour of inspection which included the ceramics laboratory, timber products, temperature and humidity test rooms, switchboard lamp developments, mechanical wear test, step-by-step, P.B.X. and crossbar laboratories, vacuum tube laboratory, and the museum. F. S. Goucher then spoke to the group on *The Microphone and Research* and H. W. Dudley on *The Vocoder*. Both talks were accompanied by demonstrations. P. B. Findley, L. S. O'Roark and M. B. Long acted as guides on the trips which were arranged by G. F. Fowler.

John Mills attended the conference as a member and presented a paper entitled *Our Experience with World's Fair Exhibits*.

#### PART-TIME POSTGRADUATE STUDY PLAN

EIGHTEEN APPLICATIONS for participation under the Part-Time Postgraduate Study Plan have been approved for the fall term. Of these, seventeen are for enrollment at Columbia Uni-

versity and one at New York University. This plan, which was announced by the Personnel Department on August 14, provides an opportunity for advanced study of a type not available in evening colleges or in the Out-of-Hour Courses. Members of the technical staff who have been regularly employed for at least one year and who hold a bachelor degree in arts, science, or engineering are eligible.

During the last school year six men who participated in the plan had degrees conferred upon them. From Columbia University R. R. Blair received the degree of Master of Arts in Physics, G. S. Phipps the degree of Master of Science in Metallurgy, and R. L. Taylor and H. C. Theuerer degrees of Master of Arts in Chemistry. C. C. Fleming and H. A. Sauer received the degree of Master of Science in Physics from New York University.

#### M. B. LONG APPOINTED TO HANDLE MURRAY HILL PROJECT

TO COÖRDINATE THE WORK of the various organizations and individuals who will be concerned with the building and equipping of Bell Telephone Laboratories' new laboratory at Murray Hill, N. J., M. B. Long has been appointed Assistant to Executive Vice-President, reporting to Dr. O. E. Buckley. Reporting to Mr. Long will be: J. G. Motley, Construction Engineer; E. V. Mace, Space Assignment Engineer; C. A. Chase, Field Representative; and C. T. Siebs, Power Systems Engineer. Mr. Siebs was formerly with the Engineer of Plant of the Western Electric Company. George B. Small of the Accounting Department will be responsible for all of the plant and expense accounting phases of the work.

Recently Mr. Long coöordinated a wide variety of activities in the construction of the Bell System exhibit at the New York World's Fair. Previously he had similar responsibilities for the exhibits in the Chicago Exposition of 1933 and those at Dallas and San Diego. In the construction and equipment of the three-million-dollar building which the Laboratories will erect, Mr. Long will act as liaison officer between Dr. Buckley and the architects, builders, and Laboratories engineers.

#### "ATOMS IN ACTION"

THROUGHOUT THE RECENTLY published book *Atoms in Action* by George Russell Harrison, Director of the Research Laboratory of Experimental Physics at M.I.T., many references are made to the work of Bell Telephone Laboratories and to various members of its Technical Staff. In general, the book indicates the great debt that our modern civilization owes to scientific research and development. Each of the sixteen chapters,



*M. B. Long*

except the first and last, takes up one particular industry; and shows how research, unconcerned for the most part with immediate problems of commercial application, unearthed the underlying facts, and thus permitted a rapid and extensive development.

Each chapter is headed by a short quotation applicable to its subject. At the head of Chapter 2, on telephony, H. D. Arnold is quoted: "Now with one broad sweep the barriers of time and space are gone and all the world becomes our vocal neighborhood." In the first paragraph of this chapter, Dr. Harrison refers to the telephone system as "the most complicated mechanism ever devised by the human mind," and Bell Telephone Laboratories as "the leading research and development organization of the telephonic art," where "more than three thousand men and women are working on telephones and associated apparatus that we will be using next year, in ten years, in thirty years."

A few paragraphs later he says: "The long-distance line furnishes an excellent example of the complexities frequently introduced into life by science that living may be simplified." He then quotes Dr. Jewett: "That many may be unaware, a few must be wary." He also refers to a demonstration given by Dr. Jewett in which he talked from Cambridge to California with monitoring loud speakers for the benefit of the

audience, and later to the audience over a telephone line to Charlotte, North Carolina, and back.

In a supplementary chapter, Dr. Harrison gives the sources from which he has drawn, and the organizations and individuals who have assisted him. He begins his personal acknowledgments by saying: "It is a pleasure to thank Dr. Oliver E. Buckley, Dr. M. J. Kelly, Dr. Harvey Fletcher and Mr. John Mills of the Bell Telephone Laboratories" and then goes on with a long list of others. He also gives thanks to the Laboratories for photographs. In suggesting reading he mentions *The Renaissance of Physics and Introduction to Contemporary Physics* by Karl K. Darrow; and *Signals and Speech in Electrical Communication* and *A Fugue in Cycles and Bels* by John Mills. He also recommends BELL LABORATORIES RECORD as giving up-to-date semi-popular discussions.

ASSOCIATED PRESS WIREPHOTO SERVICE  
USED BY 100 NEWSPAPERS

THE EFFECTIVENESS of the telephotographic service developed by Bell Telephone Laboratories and operated over Bell System Lines has been such that the Associated Press recently sent the accompanying map to all of its subscribers together with a 750-word news release describing the history of the service. Quoting from the release: "With its inauguration less than five years ago, the world's only news picture transmission network observed a notable

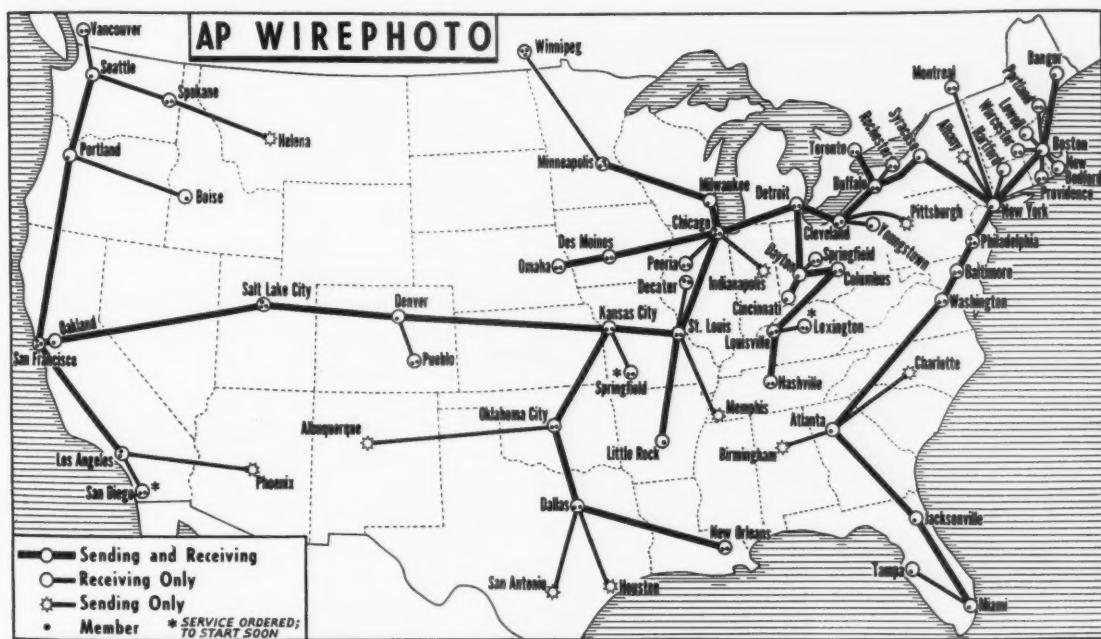
milestone today (September 20) by addition of the 100th newspaper to its list of subscribers. The international system is known familiarly to editors and readers alike as Associated Press Wirephoto. Requiring only eight minutes for each picture, it simultaneously delivers approximately 50 news photos every day to participating newspapers from Canada to Florida and from the Atlantic to the Pacific, making it possible to publish the pictorial history of almost any event within a matter of minutes after it occurs. . . .

"Still the only photo network in existence, wirephoto has grown until now it serves more newspapers by wire than all of the other picture-gathering organizations in the world combined. In addition to serving the main network points, the system also makes it possible for the AP News Photo Service to mat pictures speedily at strategic points over the country, thereby providing a fast news mat budget for upwards of 600 other members whose needs are less extensive. This service is called Telemats."

The principle of wirephoto was developed on a practical basis by Bell Telephone Laboratories and the Associated Press, under the leadership of General Manager Kent Cooper, arranged to take over the mechanism for its use in delivering pictures to its nationwide list of member newspapers.

## COLLOQUIUM

DR. FELIX EHRENFELD, formerly of the University of Vienna, spoke on *The Microcoulomb*



*In less than five years the Associated Press has linked 100 newspapers in its 12,000-mile wire-photo network which was originally developed by Bell Laboratories*

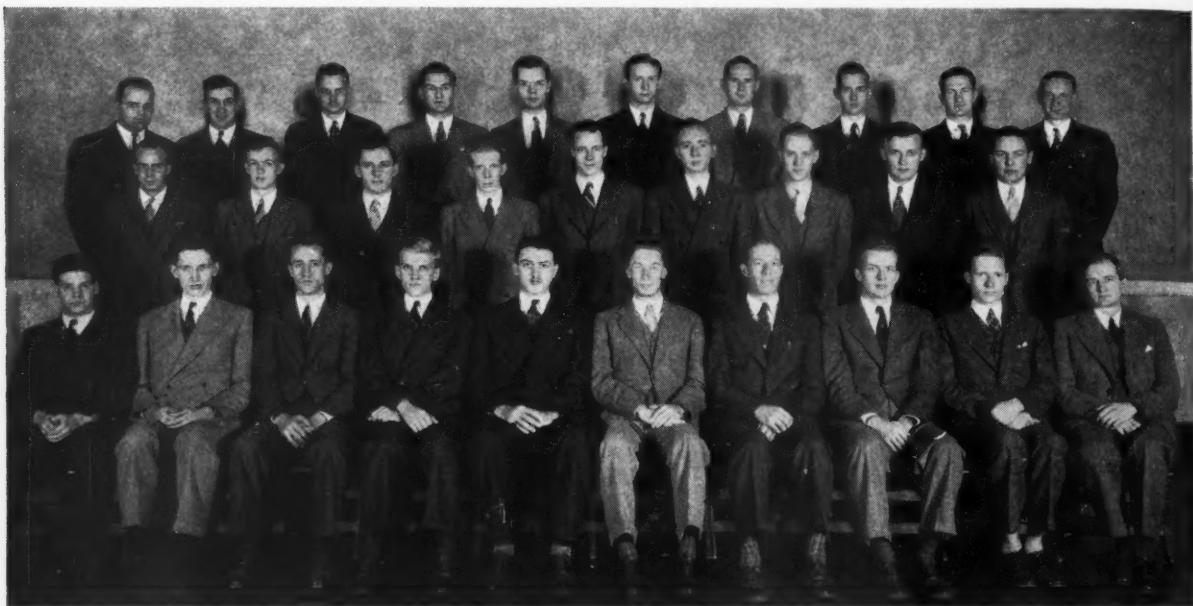
November 1939

Experiment at the first meeting of the current season held on October 9. He dealt with the determination of the sizes and charges of individual submicroscopic particles of various solid substances. The behavior of these particles in nitrogen at various pressures and in electric fields was studied with a technique similar to that used in Millikan's oil-drop experiments but using a condenser twenty times smaller. Dr. Ehrenhaft contends that on spherical particles with diameters of less than  $3 \times 10^{-5}$  cm there can be charges less than that of the electron, "e." These submicroscopic particles have been captured upon a plate, and from a study of their diffraction disks, as observed under an optical microscope, the speaker concludes that the particles are truly spheres and that their sizes and densities have been correctly assessed. He still finds charges which in his belief are definitely and unmistakably not integer multiples of "e" being indeed sometimes much smaller than "e."

#### ORIENTATION SURVEY FOR COLLEGE MEN

DURING THE PAST SUMMER thirty college men have been added to the technical staff of the Laboratories. For them an Orientation Survey, arranged by the Personnel Department, was held from September 26 to October 4. This presented a general view of the Laboratories and its place in the Bell System and a general description of departmental functions and activities. Those addressing the group included F. B. Jewett, O. E. Buckley, O. B. Blackwell, E. W. Adams, A. F. Dixon, R. L. Jones, M. J. Kelly, L. Montamat, John Mills, G. B. Thomas, H. A. Frederick, B. C. Bellows, Morton Sultzer, L. E. Kittredge, R. J. Heffner and R. A. Deller.

Inspection trips also were arranged through the various laboratories at West Street, the Long Lines building at 32 Sixth Avenue and several central offices of the New York Telephone Company. In the System Development laboratories step-by-step switching was described and



NEW COLLEGE MEN WHO ATTENDED THE 1939 ORIENTATION SURVEY,  
SEPTEMBER 26 TO OCTOBER 4

*Top Row:* K. E. Bower, 331B, *Minnesota*; K. L. Warthman, 315A, *Ohio State*; E. C. Larsen, 323C, *Wisconsin*; R. L. Slobod, 323E, *Northwestern*; D. F. Tuttle, Jr., 312B, *M.I.T.*; L. M. Gambrill, 313A, *Columbia*; T. R. Finch, 315C, *U. of Colorado*; C. H. Townes, 328, *Calif. Tech.*; W. B. Callaway, 344D, *Ala. Poly.*; and W. E. Noller, 325A, *U. of Calif.*

*Middle Row:* F. C. Griese, 332B, *U. of Okla.*; B. C. Bellows, Jr., 331B, *Cornell*; P. P. Koliss, 312C, *Worcester Poly.*; W. A. Tyrrell, 326E, *Yale*; V. C. Rideout, 326C, *Calif. Tech.*; J. T. Torian, 331B, *N.Y.U.*; R. H. Hose, 315F, *M.I.T.*; P. L. Hartman, 327F, *Cornell*; and J. J. Jansen, 341B, *M.I.T.*

*Bottom Row:* J. N. Walter, 332B, *Princeton*; J. W. Clark, 325D, *Illinois*; W. J. Brackmann, 333B, *Columbia*; J. W. Kittner, Jr., 313F, *Purdue*; J. P. Messana, 312B, *Brooklyn Poly.*; W. P. Frawley, 341C, *Worcester Poly.*; J. N. Shire, 328G, *Johns Hopkins*; M. R. Dungan, 332B, *Cornell*; W. O. Baker, 323B, *Princeton*; and J. B. Fisk, 327J, *M.I.T.*; Not present for photograph: J. H. Craig, 331B, *M.I.T.*



**J. J. KUHN**  
*of the Apparatus Development Department completed thirty years of Bell System service on September 23*



**D. D. MILLER**  
*of the Apparatus Development Department completed thirty years of Bell System service on October 13*



**F. G. C. VOLKERT**  
*of the Equipment Development Department completed thirty-five years of Bell System service on October 2*

demonstrated by P. R. Gray; toll switching, E. L. Baulch; crossbar switching, W. Rupp; cable forming, C. M. Hemmer; panel switching system and call announcer, A. S. Page; and systems power laboratory, J. R. P. Goller. In the Apparatus Development laboratories, dial apparatus by J. D. Tebo; microscopic laboratory, Miss A. K. Marshall; timber products, A. H. Hearn; dry-cell testing, J. H. Bower; linear measurements, E. C. Erickson; electric measurements, H. T. Wilhelm; and materials testing, I. V. Williams. In the Research and Transmission Development laboratories, microchemical analysis by H. V. Wadlow; microphonic action studies, J. R. Haynes; magnetic materials, D. M. Chapin; frequency standards, W. A. Morrison; transmission rating, A. Herckmans; articulation testing, W. Koenig, Jr., and vacuum tube development, S. O. Ekstrand.

#### NEWS NOTES

THE LONDON OFFICE of the American Telephone and Telegraph Company has been closed and C. W. Green, Technical Representative in Europe and formerly Carrier Telephone Engineer of the Laboratories, has returned to 195 Broadway where he will continue to handle European matters. G. W. Gilman, who was associated with Mr. Green in London, has also returned.

LEE DE FOREST, inventor of the audion or three-element vacuum tube, visited the Laboratories on September 27. He was the guest of Dr. Jewett at luncheon at which were present also O. E. Buckley, O. B. Blackwell, E. W. Adams,

M. J. Kelly, E. H. Smyth, R. A. Heising, Ralph Bown, J. R. Wilson and Lloyd Espenschied. On an inspection trip, Dr. De Forest was taken through the vacuum tube laboratory by Mr. Wilson and V. L. Ronci. At the Graybar-Varick building M. E. Strieby showed coaxial-cable repeaters, E. L. Nelson, the most recent small-boat radio-telephone set and an airplane set and also the radio altimeter, and Mr. Heising, W. P. Mason and G. W. Willard, certain piezo-electric crystal developments.

J. H. GRAY discussed matters pertaining to buried wire and small buried cables with engineers of the Associated Companies at Detroit, Chicago, Milwaukee and Des Moines.

A. H. HEARN visited the plant of the New England Wood Preserving Company at Nashua, New Hampshire, to study the commercial treatment of red-pine poles.

R. H. COLLEY attended the recent meeting of the Executive Committee of the American Wood Preservers Association in Cincinnati; visited Madison, Wisconsin, to consult on problems of timber preservation with the Forest Products Laboratory; and was in Minnesota in connection with the continued studies of shaving and full-length treatment of western cedar poles.

R. V. TERRY and W. A. MARRISON recently visited the Warren Telechron Company at Ashland, Massachusetts.

E. W. NILES and F. S. CORSO, together with members of Illinois Bell Telephone Company, attended a conference at Chicago with the Chicago Subway Commission to discuss special

telephone booths to be installed in the subway.

M. N. SMALLEY and K. E. BOWER were at Buffalo on matters connected with a trial installation of teletypewriters arranged for "leave-word" service.

W. J. FARMER and J. P. GUERARD resumed special tests on aerial-cable sheath at Chester.

C. H. GREENALL and G. M. BOUTON, accompanied by H. A. Anderson of the Western Electric Company, visited the Anaconda Wire and Cable Company at Hastings-on-the-Hudson to observe the extrusion of lead-calcium alloy cable sheath for power use.

J. C. HERBER has been at Dallas where he supervised the installation and adjustment of a 407A-1 radio-transmitting equipment for the KRLD Radio Corporation.

AT THE FOURTEENTH annual convention of the Institute of Radio Engineers, held in New York from September 20 to 23, the opening address was made by R. A. Heising as President of the Institute. Papers presented by other members of the Laboratories: *A Single-Sideband Musa Receiving System for Commercial Operation on Transatlantic Radio Telephone Circuits* by F. A. Polkinghorn; *A New Standard Volume Indicator and Reference Level* by D. K. Gannett of the Laboratories with H. A. Chinn of the Columbia Broadcasting System and R. M. Morris of the National Broadcasting System as co-authors; *Solar Cycle and the F<sub>2</sub> Region of the Ionosphere*

by W. M. Goodall; and *Diffraction and Radiation of Electromagnetic Waves* by S. A. Schelkunoff.

DURING THE THIRD QUARTER of 1939, the following members of the Laboratories have been enrolled as members of the Telephone Pioneers of America:

Josephine D. Barry	Ellen T. Leddy
W. G. Breivogel	A. D. Liguori
Fred Broome	G. A. McNeill
A. W. Dring	Mildred J. Molloy
J. J. Fennelly	H. L. Mueller
C. A. Frank	S. P. Shackleton
C. J. Gallon	Irene Spencer
A. C. Goebel	C. E. Sunderland
M. V. Hickey	N. J. Velardi
C. D. Hocker	Philip Venneman
J. F. D. Hoge	F. E. Ward
A. R. Kemp	J. R. Weeks
A. B. S. Kvaal	H. O. Wood

F. E. NIMMCKE inspected and adjusted a 405A-1 radio telephone equipment for the North Carolina Broadcasting Company at Greensboro.

J. C. BAYLES visited Elizabeth City, North Carolina, to inspect a 310B radio-transmitting equipment installed at Fredericksburg, Virginia. This radio station is operated by the Fredericksburg Broadcasting Corporation.

W. F. SMITH, JR., visited the U. S. Signal Corps Laboratories at Wright Field, Ohio, to discuss communication instruments.

ON SEPTEMBER 26, F. S. Goucher, assisted by J. R. Haynes, gave a demonstration lecture on *The Microphone and Research* before a meeting of the Engineering Foundation of Buffalo.

H. E. MENDENHALL, with C. E. Snow of the Western Electric Company, visited broadcasting stations in Boston, Portland and Bangor, and the General Radio Corporation and Massachusetts Institute of Technology in Cambridge. They discussed vacuum-tube problems and new applications for vacuum tubes.

MEMBERS OF THE LABORATORIES who were in Hawthorne during September included O. A. Shann who discussed questions relating to the manufacture of coin collectors and other station apparatus; H. O. Sieg-



*A group from the Bell System Public Relations Conference inspecting the life-testing facilities of the Laboratories. Left to right: J. T. Sheafor, Michigan Bell Telephone Company; Z. Z. Hugus and T. T. Cook, American Telephone and Telegraph Company; C. A. Stair, Southern Bell Telephone and Telegraph Company; H. S. Hanna, Indiana Bell Telephone Company; and W. A. Kruger of the Laboratories who described and demonstrated the equipment*

mund, new switching developments; J. J. Kuhn and B. Freile, crossbar apparatus; G. A. Wahl, quality survey on transmission instruments and handset problems; W. G. Schaer, 3-A announcement system for Weather Bureau reports; J. W. Corwin, the introduction of common systems relay-rack design in crossbar offices and the shop-forming of switchboard cable; and E. J. Kane and J. L. Dow, problems relating to the development of toll and of tandem crossbar systems.

PAPERS THAT WERE PRESENTED at the Boston meeting of the American Chemical Society included *Heat of Adsorption of Water on Papers* by C. C. Houtz and D. A. McLean; *The Mechanism of Oxidation of Vulcanized Rubber* by J. H. Ingmanson; and *Hevea Latex—Effect of Proteins and Electrolytes on Colloidal Properties* by W. G. Straitiff. A. R. Kemp presented a paper for Charles Dufraisse and F. Le Bras of the Institut Français Du Caoutchouc entitled *Influence of Vulcanization on Oxidizability of Rubber*. Mr. Ingmanson was elected one of the Directors of the Rubber Division for 1939-40. Other members attending the meeting were S. O. Morgan, L. A. Wooten, C. C. Hipkins, W. A. Yager and D. B. Herrmann.

J. H. INGMANSON and F. S. MALM visited Baltimore in connection with the development of submarine cable.

A. L. SAMUEL spoke on *Velocity-Modulated Tubes* at the first meeting of the Radio Colloquium for the 1939-1940 season, held at the Deal Laboratory on October 6.

J. M. FINCH attended a meeting of Subcommittee D6 of the A.S.T.M. held at Syracuse. While at Syracuse, he visited the New York College of Forestry. Mr. Finch also went to the John A. Manning Paper Company at Troy to discuss paper problems.

H. W. HERMANCE was in Pittsburgh and Cincinnati in connection with contact studies, and in Madisonville, Kentucky, and Covington, Virginia, on corroded line-wire problems.

At a meeting of the Electrochemical Society held in New York the following papers were presented: *Tarnish Studies* by W. E. Campbell and U. B. Thomas; *An Electrochemical Study of Corrosion of Painted Iron* by H. E. Haring and R. B. Gibney; *Rate of Solution of Zinc and Aluminum While Cathodic* by V. J. Albano; and



M. P. SHERWOOD  
of the Equipment Development Department completed thirty years of Bell System service on October 4

HENRY HOVLAND  
of the Central Office Switching Development Department completed thirty years of Bell System service on October 1

*Internal Electrolysis as a Method of Analysis* by B. L. Clarke and L. A. Wooten. Others attending the meetings included R. M. Burns, C. H. Sample, E. E. Wright, R. A. Ehrhardt, A. Mendizza and K. G. Compton.

THE COMMUNICATIONS GROUP of the New York section of the A.I.E.E. has arranged a course of six lectures on *Modern Methods for Communication Measurements*. Two of these lectures will be given by members of the Laboratories—W. C. Jones, *Electro-Acoustic Measurements*, and J. G. Ferguson, *Transmission Measurements on Equipment and Lines*. W. B. Snow was chairman of the committee arranging the course.

A similar lecture course on *Metals in Industry* has been arranged by the Basic Science Group. W. C. Ellis of the Laboratories will give this course and the title of the six lectures will be *Concepts and Properties of Metallic State, Alloy Equilibrium, Metallography and Heat Treatment, Non-ferrous Material, Ferrous Material, and Magnetic Alloys*.

THE TWO-MEGACYCLE coaxial trial between New York and Princeton has been concluded and the two-megacycle repeater equipment removed. Installation and adjustment of the three-megacycle equipment between New York and Philadelphia is now in progress. During September, L. Y. Lacy was in Philadelphia to test voice-frequency noise produced by a proposed rectifier-inverter for the system. R. P. Jutson and C. S. Knowlton also made extensive tests of the power equipment that is installed at Philadelphia and Princeton.

W. S. ROSS checked ringing power plants and ringing drains at Hartford, New Haven, Worcester, Springfield, Boston and Providence.

AT PHILADELPHIA, A. E. PETRIE, H. L. MUELLER and F. T. FORSTER discussed battery problems.

J. H. SOLE spent several days at the Electric Products Company in Cleveland discussing diverter-pole generators.

A. F. BURNS and J. M. DUGUID visited the 355-type community dial offices at New City and Congers, New York, to observe the tone and ringing equipment.

G. A. HURST, at Binghamton and Johnson City, New York, checked the trial installation of the new "no-such-number" tone equipment.

W. H. SCHEER was at Jonesville, New York, in connection with the trial installation of the No. 380 crossbar dial office.

R. S. CARUTHERS has been in Oklahoma City, Oklahoma, and White Water, California, assisting with the conversion of the J-1 carrier system between these points to a J-2 system.

T. A. TAYLOR has been in Florida where he coöperated with representatives of the Rural Electrification Administration in an investigation of noise-coördination problems.

RECENTLY, C. H. GORMAN, JR., H. KAHN, and J. H. SHUHART returned to New York from West Palm Beach where they have been making tests of crosstalk on the type-J systems installed between Charlotte and West Palm Beach.

NEAR-END CROSSTALK measurements at carrier frequencies were made between opposite directional pairs in toll cables at Ticonderoga, New York, by F. W. AMBERG, H. B. NOYES and Miss E. M. RENTROP.

J. G. FERGUSON and R. W. HARPER discussed problems in connection with small dial offices with engineers of the Northern Electric Company.

N. Y. PRIESSMAN entered the Western Electric Company at Hawthorne from the University of Wisconsin in 1911. After taking the student course, which consisted of the usual shop training and installation experience in Chicago, he came to the Engineering Department at West Street with the circuit design group. From 1920 to 1924 he was on leave of absence, studying at the University of Chicago for one year and at Columbia for three years, the last two as an instructor as well. When he returned to the Laboratories he entered the Apparatus Development Department where he devoted most of his time until 1928 on the design and development of relays. Since then Mr. Priessman has been concerned with the engineering properties and applications of copper oxide varistors, silicon carbide and similar varistors, selenium rectifiers and electrolytic condensers. On the fourteenth of October a five-star emblem was given to Mr. Priessman signifying his completion of twenty-five years of service with the Bell System.

\* \* \* \* \*

R. C. FISHER joined the Voucher Accounting Department of the Western Electric Company in 1911 and a year and a half later left to continue his education. Before returning to Western Electric he went to the Mexican border with the National Guard. Early in 1916 he rejoined the Voucher Accounting Department, spending the next year on general clerical work. At the outbreak of the World War he went into the U. S. Army and for the duration of the war was with the 102nd Engineers of the 27th Division, most of the time being spent in France.

Upon demobilization in 1919, Mr. Fisher entered the billing section of the Accounting Department. He later became Assistant Auditor of Disbursements and then, for a period of five



*N. Y. Priessman*



*R. C. Fisher*



*C. H. Withrow*

years, was paymaster. Since 1929 he has been in the General Service Department in charge of the salvage group responsible for the disposition of all material and equipment that is of no further use to the Laboratories. On October 7, Mr. Fisher received a five-star button signaling his completion of twenty-five years of service in the Western Electric Company and the Laboratories.

\* \* \* \* \*

C. H. Withrow of the Systems Development Department completed thirty years of service in the Bell System on the eleventh of October. Mr. Withrow joined the Engineering Department of the Western Electric Company in 1909 as an assistant in the circuit laboratory. Later he worked in the drafting group and then became a laboratory assistant, testing and maintaining circuits in the circuit laboratory. During this time he took a three-year evening course in Electrical Engineering at Pratt Institute and one year of mathematics at Brooklyn Polytechnic Institute. During the World War he was associated in the establishment of a submarine-detector school at New London.

From 1920 to 1928 Mr. Withrow was in the central office circuit group concerned with the development of machine switching systems, principally of the panel type. He transferred to Electrical Research Products Incorporated in 1928 to install and service sound picture equipment. He soon was made District Supervisor, covering this work in Northern and Western New York. He also made many acoustic studies and surveys of theaters in this and other territories. Mr. Withrow returned to the Laboratories in 1937 and since that time he has been continuously engaged in circuit development work in the panel group of the Central Office Switching Development Department.

\* \* \* \* \*

L. F. Staehler has returned from Texas where he was engaged in making high-frequency measurements on open wire.

TYPE-C SYSTEMS have been installed on the Union Pacific Railroad line between Omaha and Cheyenne and between Cheyenne and Salt Lake City. In connection with these, N. Monk visited Omaha, Cheyenne, and Salt Lake City.

B. C. GRIFFITH and H. H. FELDER made measurements at Phoenixville of the characteristics of drop wire and auto-transformers for emergency use in repairing breaks on open-wire carrier lines.

A PAPER by J. R. Pierce entitled *Limiting Current Densities in Electron Beams* was published in the October issue of the *Journal of Applied Physics*.

UNBALANCE MEASUREMENTS on a special CSA subscriber cable were made in Washington by F. W. Amberg and N. V. Firth.

November 1939

E. B. MECHLING, in Boston, tested noise and crosstalk aspects of the new two-wire repeater.

A. J. AIKENS has been making field tests of crosstalk in type-J carrier systems at Winnsboro and Denmark, South Carolina.

DURING THE MONTH of October the following members of the Laboratories completed twenty years of service in the Bell System:

*Apparatus Development Department*

G. B. Baker	J. M. Peabody
W. H. Berthold	D. A. Quarles
E. B. Payne	C. R. Taft

J. R. Townsend

*Research Department*

G. W. Ames	Frank Gray
	R. P. L. Piltan

*Systems Development Department*

J. W. Dehn	Elith Hansen
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*Transmission Development Department*

C. C. Taylor

*General Service Department*

Louise Van Bergen

<i>Plant Department</i>	<i>Legal Department</i>
Walter Connick	Loretta M. McMahon

*Patent Department*

G. T. Morris	P. C. Smith
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P. F. JONES has been in Boston in connection with active balance measurements on two-wire circuits using a resistance noise generator.

R. D. FRACASSI has been in New London and Danielson, Connecticut, initiating tests of thermistors on H-88-50 cable circuits between those points to stabilize the attenuation as temperature changes.

DURING OCTOBER, H. A. Affel, B. W. Kendall, L. G. Abraham, E. N. Little, P. G. Edwards and R. L. Case observed the trial of the new two-wire repeater at Boston, Greenfield, and Fitchburg, Massachusetts. Actively engaged in the trial, now completed, were: A. L. Bonner, C. Breen, W. B. Callaway, R. D. Ehrbar, H. A. Etheridge, Jr., R. D. Fracassi, P. F. Jones, M. R. Kleist, E. B. Mechling, S. T. Meyers, H. W. Nylund, L. C. Roberts, V. E. Rosene, E. M. Staples, A. C. Thompson and T. J. Young.

L. E. COON attended lecture meetings of the Greater New York Safety Council.

THE SEPTEMBER MEETING of the Metropolitan Chapter of the American Society of Safety Engineers was attended by R. L. Young, H. E. Crosby and L. E. Coon.

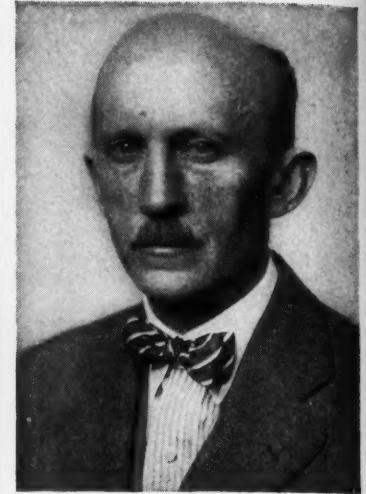
JOHN MILLS, in a luncheon talk to Naval Academy Graduates at the Downtown Athletic Club in New York, spoke on *Trends of Research in Electrical Communication*.



*Edward Sullivan, 1905-1939*



*R. E. Noble, 1877-1939*



*E. R. Lundius, 1874-1939*

E. B. CAVE and H. S. WERTZ were at the Patent Office during September relative to routine patent matters.

F. M. NOLAN appeared before the Primary Examiner at the Patent Office in interference proceedings.

H. B. FISCHER recently attended a meeting of the Radio Technical Committee for Aeronautics in Indianapolis.

G. N. THAYER was in Indianapolis for a demonstration of the Civil Aeronautics Authority's instrument-landing system.

A. B. BAILEY and H. A. HAY were in Washington to assist in a radio-transmission survey for the Chesapeake and Potomac Telephone Company.

THE WESTERN ELECTRIC 443A-1 (1-kw.) radio-transmitting equipment described in the September RECORD was featured in the Graybar exhibit at the I.R.E. Convention in New York City. The exhibit included a complete demonstration of performance, using a cathode ray oscilloscope and distortion-measuring equipment. The demonstration was conducted by H. A. Reise, R. E. Coram and W. H. Doherty.

\* \* \* \* \*

DURING SEPTEMBER three deaths occurred through which the Laboratories lost one active member and two retired members. Edward Sullivan of the Building Service Department, with service from 1929, died on September 27; R. E. Noble of Hendersonville, North Carolina, who retired in 1931 after thirty-one years of service, on September 26; and E. R. Lundius of Great Neck, Long Island, who retired in 1933 after forty years of service, on September 30.

Mr. Sullivan was born in Ireland and immediately upon coming to this country joined the Plant Department of the Laboratories as

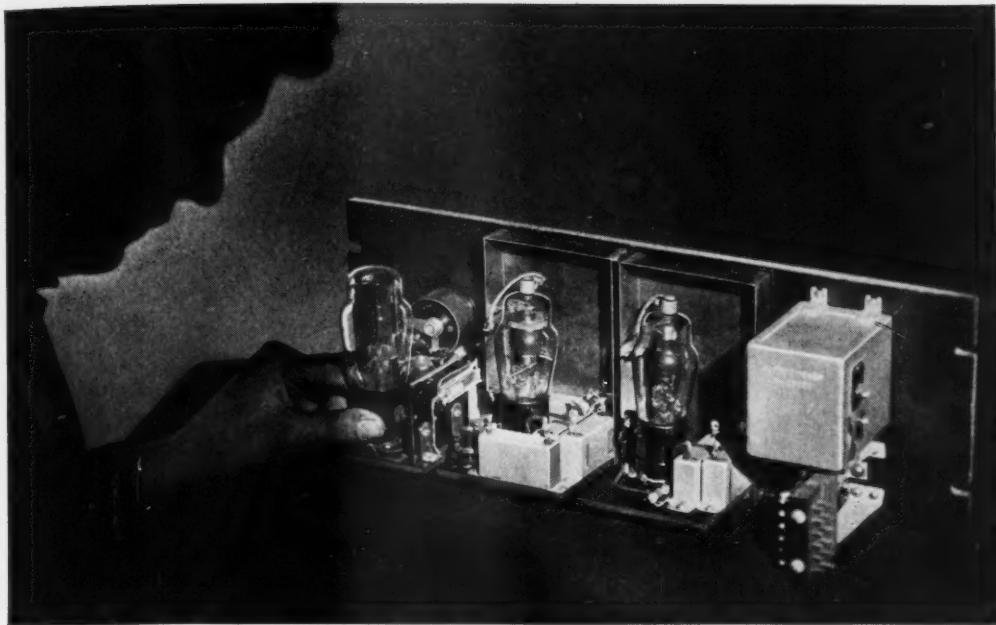
a night cleaner. A few years later he became a uniformed watchman assigned as a guard on various entrances of the building.

Mr. Noble, after earlier service dating from 1898 with the Chicago Telephone Company during which he was installer, foreman of installation, wire chief, and general inspector, became a member of the Equipment Engineering Department of the Western Electric Company at Hawthorne. He came to New York in 1914 to join those engaged in the development of the panel-type equipment. He had an important part in the panel program from the time of the original installations in Newark and was responsible for many equipment design features of the arrangements for framework structures, trunking, and cabling, from which have been developed the present standards. From 1925 until the time of his retirement, Mr. Noble was a supervisor of the general standards group in the Equipment Development Department.

Mr. Lundius' telephone experience began as a cable tester for the New York and New Jersey Telephone Company. With the introduction of the common battery system in 1899, he became engaged in switchboard maintenance work in New York City. In 1905 he went to the San Joaquin division of the Sunset Telephone and Telegraph Company as a wire chief, and, except for a short time in the District Inspector's office in New York, remained in the west until 1914 as wire chief of various divisions of the Pacific Telephone and Telegraph Company, and later as Equipment Superintendent in Seattle. In 1915, after a year in the Engineering Department of the New York Telephone Company, Mr. Lundius came to the Laboratories where he was in charge of a group handling manual systems development until his retirement.







## Gas-Tube Noise Generator for Circuit Testing

By E. PETERSON  
*Circuit Research*

ONE of the important problems in the design of multi-channel carrier-telephone systems is the avoidance of interference between channels. This particular type of interference may arise from cross-modulation in vacuum tubes and in coils with ferromagnetic cores, since the several channels traverse line amplifiers and terminating networks in common. It may appear as intelligible or unintelligible crosstalk, either of which lowers the quality of transmission. For this reason stringent limitations are imposed upon cross-modulation.

To test whether or not a system meets these requirements is a relatively simple matter when only a few channels are involved. The custom-

ary procedure in that case is to load some of the channels with talkers arranged to simulate practical conditions, and then to make observations in one of the unoccupied channels. These observations may consist of either noise meter readings or of listening tests. When a system with a large number of channels is involved, such as the 240 provided for in the New York-Philadelphia trial coaxial cable, it becomes exceedingly cumbersome and expensive to provide enough talkers to load the system. For these conditions a comparatively simple testing means is needed.

Before a suitable testing wave can be devised, it is necessary to establish the properties of the waves transmitted under practical operating con-

ditions. The wave form can hardly be dealt with directly because it is a highly fluctuating affair, which varies in form and magnitude from moment to moment, since it is the composite of modulated speech currents from many active channels. The information needed can be gotten, however, from statistical studies of such waves, which yield their voltage distributions. These tell the fraction of time during which any given voltage is exceeded.

Studies of this nature have been carried out by H. K. Dunn and M. E. Campbell for composite speech produced by different numbers of talkers. Figure 1 shows some of their results for one, four, sixteen and sixty-four talkers respectively. The ratio of the observed to the root-mean-square voltage is plotted in db against the percentage of time during which that voltage ratio is exceeded. These curves become progressively flatter over the greater part of the range as the number of talkers increases, until finally, when sixty-four or more talkers are used, the distribution curve ap-

proximates more and more closely the normal distribution illustrated by the dashed line in Figure 1. The approximation to the normal distribution as a limiting form is to be expected on the basis of probability theory.

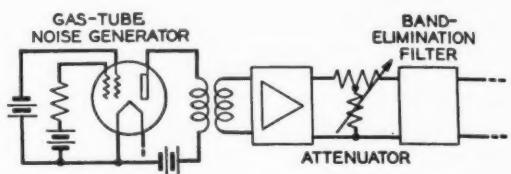


Fig. 2—Circuit of the noise generator used in testing multi-channel telephone systems

These results indicate that a test wave suitable for a large number of channels should have a normal distribution of amplitudes, and should be spread out more or less uniformly along the frequency band occupied by the carrier systems. Fortunately voltage sources with these characteristics are obtainable. One such source, which is sometimes referred to as resistance noise, is developed by the random motion of electrons in conductors. To produce a uniform output of resistance noise over a band extending to one megacycle at a level sufficient to load the system would require a carefully constructed high-gain amplifier. Another source more easily adapted to the purpose is found in the gas-tube noise generator. In this device an arc is formed and confined within the space between the cathode of the tube and a grid next to it. Electrons which escape from the arc-space through the

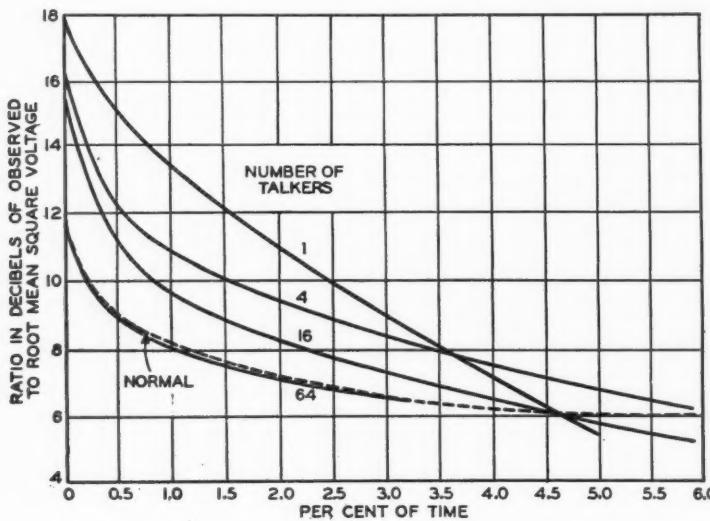


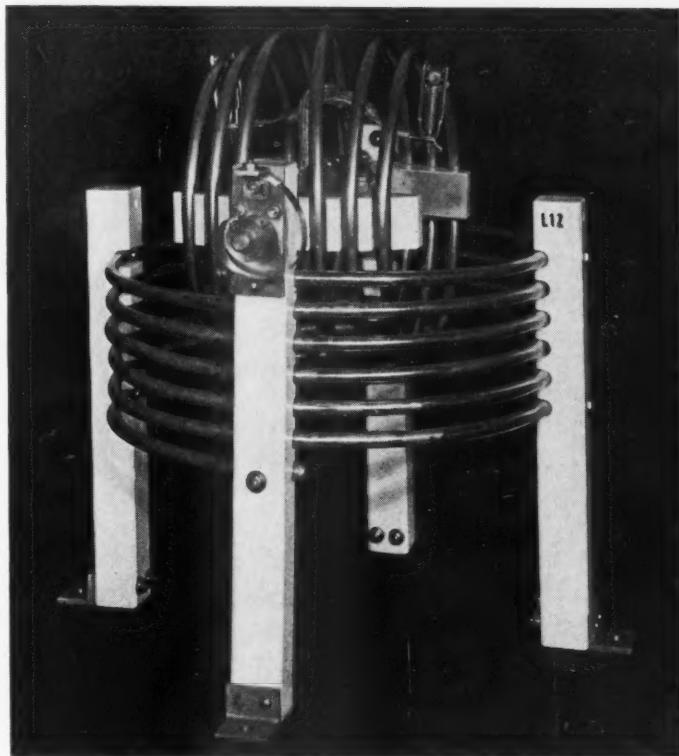
Fig. 1—The voltage distribution of the voice currents from a group of talkers approaches a normal distribution more closely as the number of talkers increases

inner grid-mesh are drawn over to the plate. The tube circuit used is shown in Figure 2. In an experimental model of this noise generator the output power developed stayed constant within two db for frequencies up to one megacycle, close enough for present purposes.

The method adopted for using this source in laboratory testing is one previously applied to the measurement of cross-modulation effects associated with transatlantic radio circuits. A band-elimination filter is connected to the noise generator output so that the noise output remains unaltered over the whole frequency range except for the eliminated band, where the output voltage is reduced to a negli-

gibly small value. The eliminated part must be at least one channel wide. By connecting the output of the filter to the coaxial system to be tested and measuring the output of the system over the frequency range covered by the eliminated band, we obtain a measure of the cross-modulation. It should be noted that other kinds of interference, such as background noise, can be separated from the cross-modulation by measurements taken with the noise generator removed. Results of this kind make it possible to determine the cross-modulation expected when a system is loaded by talkers, without incurring the physical complications of tests that are involved with a large number of talkers.

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*Branching circuit coil of the No. 33B directive antenna control unit in the Western Electric 50-kilowatt radio-transmitting equipment*



## Single-Sideband Short-Wave Receiver

By J. C. GABRIEL  
*Radio Research*

factory receiver were obtained from these earlier studies; new apparatus has been designed and is now in operation on two of the circuits between New York and London and on the one between San Francisco and Honolulu. This new receiver differs from the earlier model,\* however, in providing for the reception of two speech channels—one in the band above and the other in the band below the carrier.

By suppressing the carrier and using the entire amplitude capacity of a transmitter for the sideband, an improvement of 6 db is obtainable. This is equivalent to a four-fold increase in radiated power. The amount of noise at the receiver, on the other hand, is proportional to the width of the transmitted band; and by cutting this width in half, through use of only a single sideband, the noise is halved, or reduced by 3 db. The signal-to-noise ratio thus becomes 9 db greater. Put in practical terms, this means that for the same signal-to-noise ratio at the receiver, the radiated power can be reduced to one-eighth of that required for the usual double-sideband method of transmission.

The new receiver is designed to operate over the frequency range from

**S**INGLE-SIDEBAND short-wave transmission has been a subject of experimental study by the Laboratories for many years. In 1934 practical trials were made, in conjunction with the British Post Office, which have led to certain commercial applications. As already described in the RECORD,\* one of the sidebands resulting from modulation was suppressed; and the carrier was greatly reduced in volume so that practically all the energy transmitted was in the remaining sideband.

Because of the satisfactory results of these trials it was decided to use single-sideband transmission on some of the commercial transoceanic circuits. The requirements for a satis-

\*May, 1936, p. 303.

four to twenty-two megacycles. To simplify construction, this range is divided into two bands, one from four to ten and the other from ten to twenty-two megacycles, with a separate high-frequency amplifier and first demodulator for each. High selectivity is required in the separation of the two sidebands and the carrier. Since this is most readily obtained by crystal filters, it was desirable to have the frequency at the point of separation in the range most favorable to the manufacture of crystal filters. 100 kc was selected as the frequency of the carrier at this stage of the circuit. A crystal filter with a pass band only forty cycles wide is used to separate the carrier; two crystal channel filters—one with a band from 94 to 99.9 and the other with a band from 100.1 to 106 kc—are used for the two channels. Although each sideband is 6 kc wide, the voice channels under twin operation are somewhat under 3 kc wide. One is adjacent to the carrier, and the one on the other side is separated by about 2.5 kc from the carrier.

If the incoming carrier, of perhaps 20,000 kc, were reduced to the intermediate frequency of 100 kc in one step of modulation, the frequency of the beating oscillator would be separated from the carrier by only 0.5 per cent, since the difference between them would be only 100 kc. Under these conditions a disturbing frequency only one per cent away from the carrier, and on the same side as the beating oscillator, would also appear, after demodulation, at 100 kc. Since it is very difficult to make a filter at twenty megacycles that will attenuate a frequency only one per cent away sufficiently to make it negligible, two modulating steps are provided between the incoming carrier and the final intermediate fre-

quency of 100 kc. The circuit arrangement is shown in block schematic form in Figure 1. The second beating oscillator is fixed at 3000 kc. The first beating oscillator is adjustable from seven to nineteen megacycles, and is tuned to 2900 kc above or below the carrier so that at the input to the second demodulator the carrier will have been reduced to 2900 kc. After the second demodulator—with a 3000-  
kc beating frequency—the carrier will thus be 100 kc.

If this were an ordinary double-sideband system, the frequency bands resulting from the second demodulation—assuming a 6000-cycle voice band—would extend from 94 to 106 kc and by making the output filter somewhat wider than the desired 12 kc, say from 90 to 110 kc, sufficient margin would be provided so that if the incoming carrier or the beating oscillators should vary somewhat from their nominal values, the band would still pass through the filter, and the full voice band would be available at the output of the final detector.

With twin sidebands, however, the situation is different. In the first place the carrier must be separated from the two sidebands so that it may be amplified separately to make up for the reduced value at which it is transmitted. Moreover, the carrier filter must have a very narrow pass band or the reduced carrier would be lost in the noise at adjacent frequencies. For this reason the pass band is made only forty cycles wide, and the frequency of the carrier at the output of the second demodulator must be held at 100 kc to within very close limits or it will not be passed. A variation in a ten-megacycle carrier of only one thousandth of one per cent would more than absorb this entire margin.

Such displacement is prevented by

use of a local 100-kc oscillator of very high precision to fix the carrier frequency at the output of the second demodulator. The locally generated 100 kc from the "reference oscillator" of the schematic is passed through a phase shifter to produce a two-phase voltage at 100 kc. The frequency of the carrier output of the second demodulator, which is also 100 kc if the two beating oscillators and the incoming carrier are at their nominal values, is combined with the two-phase oscillator output in a modulator using two pairs of push-pull pentodes. A two-phase output is thus secured which will have a frequency equal to the difference in frequency between the two nominally 100-kc inputs. A two-phase motor connected to this output is geared to a small variable

condenser associated with the first beating oscillator. When the 100-kc oscillator and the carrier output of the second demodulator are at exactly the same frequency, this motor does not run. As the carrier deviates from the 100-kc oscillator frequency, however, the motor will run in one direction or the other depending on whether the carrier is higher or lower than the oscillator. The variation in capacity of the small condenser produces a change in the frequency of the first beating oscillator until the frequency of the demodulated carrier becomes equal to that of the 100-kc oscillator. It will be noted that this correction will be made regardless of whether the original frequency deviation was in the incoming carrier or in either the first or second beating oscillators.

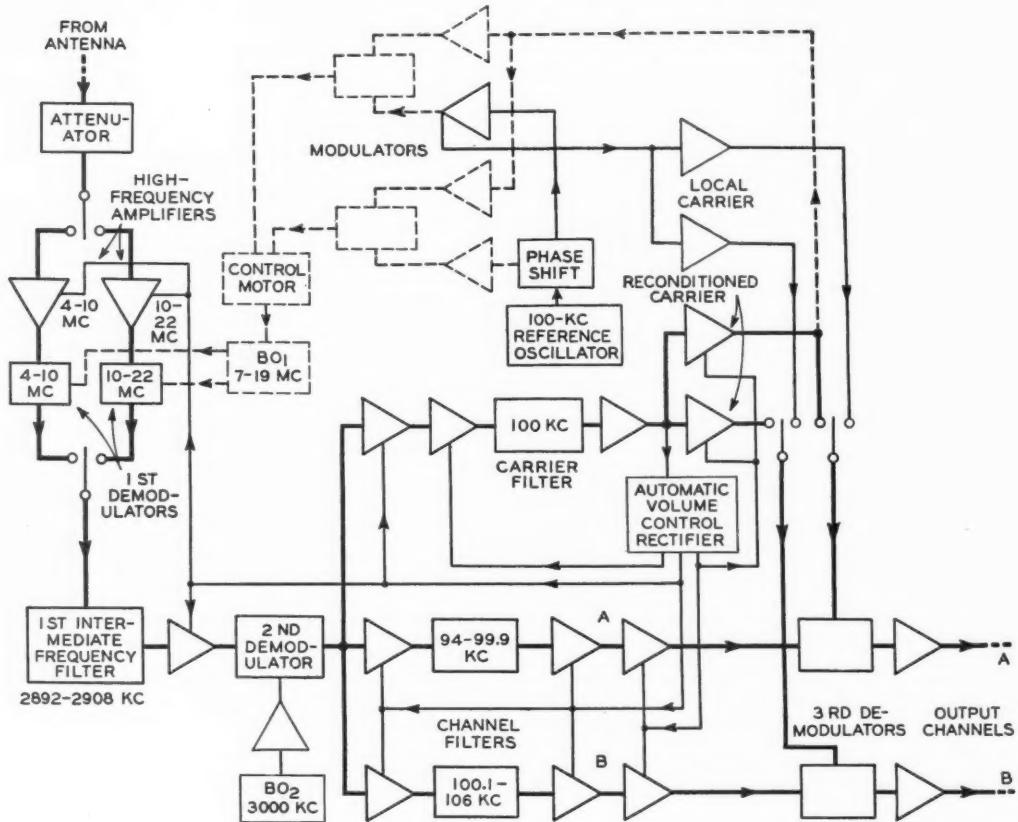


Fig. 1—Block schematic of the circuit arrangement

This 100-kc oscillator may also be used to supply the carrier in the third demodulator by operating a manually controlled switch indicated in Figure 1. Such an arrangement is very helpful during periods of deep fading when, without it, the signal would suffer large changes in volume because of the selective fading of the demodulating carrier and the side-band. Operation of this switch does not affect the frequency control of the first beating oscillator since there is an adequate incoming carrier except during the momentary fades, which are so short that there is no perceptible change in carrier frequency. Under these deep fading conditions the frequency control of the first beating oscillator is particularly important, since a variation of only a very few cycles would result in distortion of the output due to a shifting of the harmonics of the signal fundamentals. If, for example, the first or second oscillator should shift ten cycles, the output of a 200-cycle fundamental and its harmonics, when demodulated by the 100-kc oscillator, would be 210, 410, 610, 810, etc., each being increased by ten cycles. The fact that the fundamental was increased by ten cycles would not be serious, but noticeable distortion would be introduced because the demodulated harmonics were no longer exact multiples of the fundamental. The frequency control, however, is so accurate that these effects are entirely unnoticeable.

The separately amplified carrier also supplies automatic gain control to the entire receiver. The control for the carrier amplifier branch is sup-

plied through a fast-acting circuit so that changes in gain are made promptly. The control for the two channel branches, however, is supplied through a slow-acting circuit, so that the full gain change will be applied to these amplifiers after an appreciable time interval. This arrangement avoids the sudden change in gain that might otherwise occur during carrier fades. By slowing down the action of this part of the automatic gain-control circuit, the fade has passed before more than a small part of the change in gain has been made, and these undesirable changes are avoided.

The receiver is assembled in three cabinets each seven feet high and twenty inches wide. Each has a door at the back; and the three cabinets are bolted together to form a single unit as shown in the photograph at the head of this article. The left-hand cabinet contains all the high-frequency circuits including the first intermediate-frequency filter and amplifier, the second demodulator, the first beating oscillator and its frequency control. The middle cabinet includes equipment for the two channel branches, and the 100-kc oscillator. In the right-hand cabinet is the complete carrier branch equipment, the second beating oscillator, and the rectifiers for plate and grid supplies. Power is taken entirely from a 110-volt a-c commercial supply; and each amplifier and modulator unit contains its own transformer for filament supply. The plate voltages and the grid-biasing voltage are supplied from separate rectifiers to prevent reaction between the various units.



## Testing Shields for Carrier- Frequency Line Structures

By M. C. BISKEBORN  
*Outside Plant Development*

and except for refinements the apparatus has remained practically unchanged. It consists essentially of two slender coils which are mounted in a frame and arranged so that a shield may be placed over one of the coils without changing their relative position. The other coil acts as a pick-up and the effectiveness of the shield is measured by the ratio of the current in the pick-up coil with and without the shield

over the disturbing coil. In practice, this ratio is measured directly in db and the shielding effect is thought of as a loss expressed in this unit. Other factors not measured directly by this method affect the crosstalk in long cables, but the method is of great practical value because it permits comparison of different designs based on calculations from these other factors of the amount of shielding needed.

The accuracy of the test-coil method of measuring the shielding effect of solid cylindrical shields was demonstrated by the agreement found between experimental and calculated values of the shielding ratio. The difference in most cases was less than one db.\* Materials which had different resistivities were checked over

\*RECORD, Mar., 1936, p. 229.

**S**HIELDING is one of several methods used to prevent interference and reduce crosstalk between circuits in telephone cables. It is especially useful in carrier-telephone systems which cover broad-frequency bands and have repeaters of high gain. To study the effectiveness of different shields by manufacturing even relatively short lengths of cable is slow and expensive. Methods of measuring short samples and the application of these methods to specific interference problems have, therefore, been investigated.

Shields were first used on telephone circuits about 1915 to protect entrance cables on open-wire carrier lines. Measurements of the effectiveness of cylindrical shields were begun by the Laboratories some years later,

a range of frequency and of thickness. Test results and calculations for composite shields which consisted of alternate layers of various materials also were in good agreement.

The test-coil method has been applied to short sections of cable shields, which generally consist of several metal tapes assembled in various ways to form a cylindrical structure. Short handmade samples of the taped shield have also been studied to determine the effect on shielding of structural variables such as length of helix, width, thickness, composition and arrangement and number of tapes and overlap or gap between the turns of each tape. A similar investigation would be expensive if carried out on complete cables long enough for crosstalk tests. Furthermore, an average of many crosstalk tests on a given cable would be required in studying the quality of a shield because differences in crosstalk between pairs tend to obscure differences due to the construction of the shield.

The test coils revealed the important fact that a composite shield, made of alternate layers of copper and iron, is more effective for ordinary thicknesses over the usual frequency range

when the iron is sandwiched between layers of copper. This is because the reflection loss between copper and air is very much higher than that be-

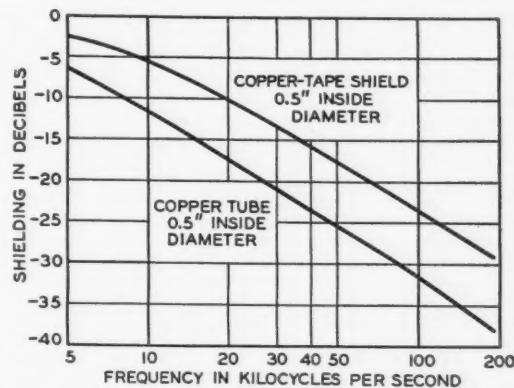


Fig. 1—Comparative shielding effect of two shields, one consisting of two layers of copper tape and the other of a copper tube of the same size. The outer tape covers the gap between the turns of the inner tape

tween iron and air, due to the difference in their impedance ratios.

For equal total thicknesses of iron and copper in a copper-iron-copper and an iron-copper-iron shield the total attenuation loss is the same but the extra reflection loss in the copper-iron-copper shield increases its shielding effect. Some, or even all, of this

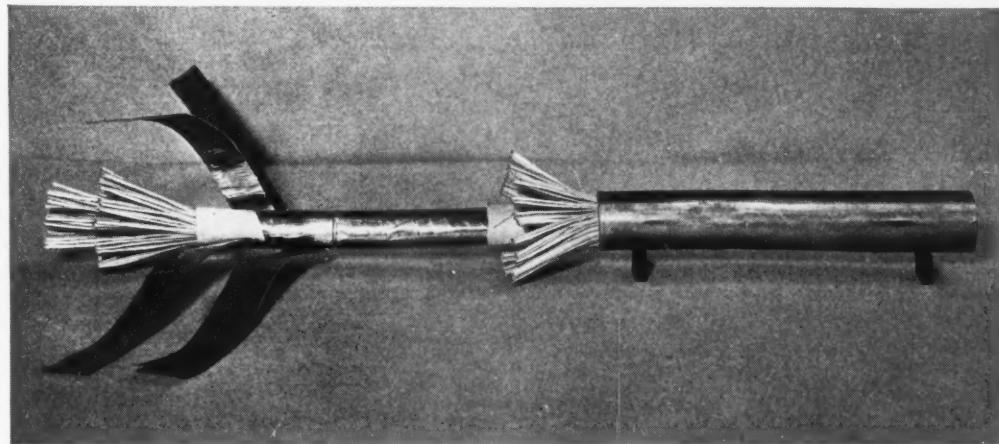


Fig. 2—Sample of a cable shielded with thin metal tapes

gain may be lost, however, if the amount of iron is made smaller in the copper-iron-copper than in the iron-copper-iron shield because the attenuation loss per unit thickness is higher for iron than for copper. This arrangement of layers has been used in many shields, and has the added advantage that the transmission characteristics of circuits in the vicinity of the shield are less affected by the proximity of copper than of iron.

With a simple and accurate means of measuring the effectiveness of cable shields available, there remains the problem of expressing quantitatively the effect of the shield on the interference or crosstalk in a given cable. In a cable with balanced pairs the insertion of a shield between two pairs or groups of pairs reduces the electrostatic crosstalk essentially to zero and the electromagnetic crosstalk by the shielding ratio. In a coaxial cable, on the other hand, the relation between shielding effect and crosstalk differs from that of a balanced-pair cable in that the shield forms one side of the circuit. In this case the transmission current tends to flow on the inner surface of the outside conductor because of the skin effect associated with high frequencies. A disturbing current, due either to crosstalk from another coaxial circuit or to induced voltages from sources outside of the

cable, tends to flow on the outer surface of the outside conductor. If the wall of the outer conductor is thick and the frequencies are high, the two currents flow with more or less complete independence of each other. The transfer of energy between the two surfaces may be shown to be closely related to the shielding effect of the outer conductor as measured by test coils. Hence the degree of independence of the transmitted current from the interfering current may be expressed quantitatively in terms of the measured effectiveness of the shield. In both the balanced and the coaxial types of structure the total crosstalk over appreciable lengths of cable is complicated by the interaction of tertiary circuits which are present.

With the aid of test coils, shields have been designed to meet specific crosstalk limits for cables of different general classifications. The method has been of particular value in the design of cable shields for type-K carrier systems, which have go and return channels inside the same lead sheath but separated from each other by the shield. Shields have likewise been designed for broad-band carrier cables which have balanced pairs and quads individually shielded. Test coils have also been used extensively in the study and design of outer conductors that are used in coaxial cable.

# Remote Control of Radio Systems

By H. M. PRUDEN

*Switching Development*

THE location of antennas is generally controlled by factors affecting radio reception or transmission, and thus the most favorable site may very likely be at some distance from the central office through which the radio and land channels will be connected. The radio receivers and transmitters must be near the antennas, and in the past this has required the establishment of the station operating force at some distance from the switching center. For the smaller radio links, where the equipment is simpler and the operating attention required is too small to justify the establishment of a permanent operating staff, the radio equipment has been designed for remote control, and all operating is done from the connecting central office. With this arrangement periodical visits to the radio station are all that is required for ordinary maintenance. This method, which was first used with aeronautical ground stations, has also proved effective for radio receivers in ship-shore or harbor craft service, and for both transmitters and receivers for such low-power radio links as that between Green Harbor and Provincetown.\*

The operating functions that must be remotely controlled vary, for the most part, with each installation, so that standardization has not been feasible. In all cases, however, a variety of control pulses transmitted over the voice line between the radio

terminal and the central office are employed to actuate a suitable set of relays. An example of one of the simpler forms of control circuit is that used for the pole-mounted radio receivers and transmitters at Provincetown. Here it was necessary to be able to turn on either the receiver alone, or the receiver and transmitter together, or to add to the circuit an oscillator for test purposes.

As shown in Figure 1, a simplex control circuit was formed by a connection to the midpoint of the transformers both at the telephone terminal and at the radio equipment. With this arrangement, the control current flows over both sides of the telephone line in the same direction, and by using a combination of positive and negative pulses to ground, with a suitable combination of relays at the radio terminal, either the receiver, or the transmitter and receiver, may be turned on, or both of them may be turned on together with the test oscillator to set up a test.

With this system two keys are provided at the telephone office: one to connect positive and one negative battery to the simplex circuit. With neither of these keys operated, relay A at the radio terminal is operated, and neither receiver, transmitter, nor oscillator is in operation. To bring in the receiver alone, the positive battery key is operated at the central office, and positive current flowing over the line operates the receiving relay at the radio terminal. This re-

\*RECORD, Oct., 1934, p. 34.

leases the A relay through a back contact, thus putting ground on the receiver control lead and turning on the receiver, and operating the test relay to prevent operation of the test oscillator.

To bring in the transmitter in addition, the polarity of the control current is changed by operating the negative key. This releases the receiving and operates the transmitting relay, and the latter energizes the transmitter through its front contact. During this transition the  $A$  relay remains released because of its slow-operate characteristic, and thus the receiver remains in operation and the test relay is held operated to prevent the excitation of the test oscillator.

To test the receiver operation, the receiver, transmitter, and test oscillator must all be in operation at the same time. To bring about this condition, both keys at the telephone office are restored to the normal position, which allows the A relay to operate, and the test relay to release and start the oscillator. The negative key is then operated, which actuates the transmitter relay, bringing in the transmitter, and opens the circuit to the A relay—thus allowing it to release and bring in the receiver.

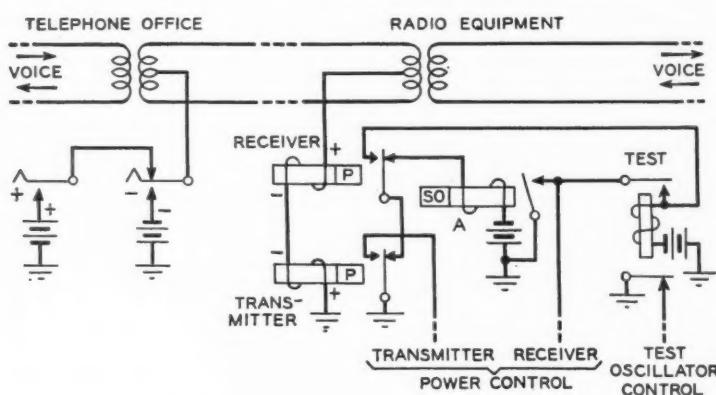
With such a simplex control circuit there are three possible conditions of current flow—positive current, negative current and no current—and by employing various sequences of two or three of these conditions, and suitable relay combinations at the radio terminal, a number of operations may be secured. A few years ago a circuit of this type was employed to control frequency and antenna selection at a radio transmitter.\* A key at the control station connects a telephone dial to either an antenna-change or frequency-change circuit, and the subsequent dialing selects the antenna or frequency desired.

The arrangement of apparatus for this is shown in Figure 2. When the dial is pulled back, battery is connected to the line through the contacts of a pulsing relay, and, depending on whether this battery is positive or negative, the A relay at the transmitting station will operate the antenna or frequency-selecting relay. On release of the dial, the battery is reversed a number of times equal to the digit dialed, and the selector at the transmitter will move ahead an equal number of steps to make the desired selection. Relay B remains operated throughout the pulsing, while relay

A follows the pulses in order to actuate the selecting relay.

Instead of using a simplex circuit, it is possible to send positive or negative pulses to ground over the two sides of the line separately, or a current may be circulated around the circuit in the usual manner. Both of these latter methods

Fig. 1.—Simplex control circuit used to control radio receiver and transmitter at Provincetown



\*RECORD, Aug., 1933, p. 365.

were used recently to turn on and off a radio receiver and to control its gain.

For the 223 radio-receiving equipment,\* a combination of simplex and circulating circuit is employed. This receiver is normally energized all the time, so that no arrangement need be provided for turning it on or off. It incorporates a codan, however, that operates a relay whenever carrier is being received, and a circuit must be provided over which the carrier-operated relay can operate a relay at the central office to perform a number of circuit functions. In addition means must be provided for operating a test oscillator, reducing the gain of the receiver to meet certain operating conditions, and operating or releasing a lock-up relay used in connection with the signals transmitted when the regular power fails.

The circuit, shown in Figure 3, employs a two-position emergency power-signal key and a three-position key. One is the unoperated position, and the other two are marked "gain control" and "test oscillator control." With the keys in the unoperated positions, a circuit is closed from the positive pole of the battery through both windings of a codan-controlled relay, a simplex line circuit, through two opposing windings on each of two polarized relays at the receiver, the primary winding of the power-control relay, and thence to a front contact of the codan relay. When the codan relay operates, current flows over this sim-

plex circuit to operate the relay at the central office. This current has no effect on two of the polarized relays at the receiver because it divides equally between the opposing windings on each, and no effect on the power-control relay. It also has no

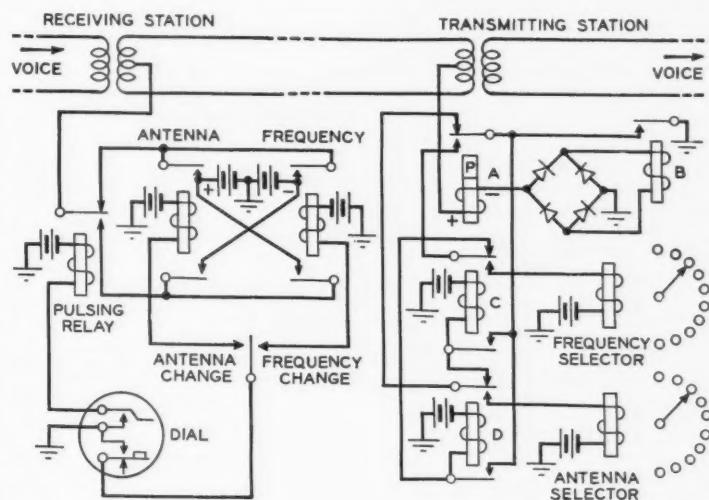


Fig. 2—Simplex dialing circuit used for selecting frequencies and antennas at Miami

effect on the operation of the line as a voice circuit; its only effect is on the codan-controlled relay.

When the three-position key is in either of the operated positions, current flows down one side of the line and back the other, and operates one or the other of the balanced polarized relays depending on the direction of flow. Operation of the gain-control key reduces the gain of the receiver to a predetermined point, and operation of the test-oscillator key in a similar manner operates the oscillator-control relay to the test oscillator.

The receiver includes an emergency power supply which is switched on automatically whenever the regular power fails, and is disconnected when the regular power comes back on. The central office is notified of a failure of

*\*Page 76, this issue.*

the power by a circuit at the receiver that connects the test oscillator and transmits a steady tone. Since the circuit cannot be used while the tone is on, an additional control circuit is provided to disconnect the tone after the power failure has been noted at

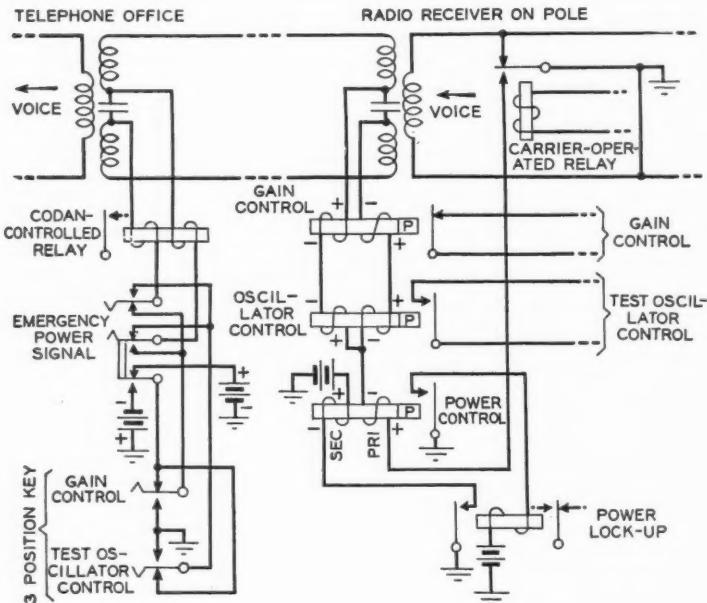


Fig. 3—Control circuit for 223A radio-receiving equipment

the central office. The tone is also applied when the regular power comes back on, and then another control circuit is required to remove the tone.

To stop the test tone after the receiver has transferred to the emergency battery, the emergency power-signal key at the central office is operated. This key switches the entire control system from negative-grounded battery to positive-grounded battery, and reverses the circuit so that the three-position key operates in the

normal manner. Change in the polarity of the signaling battery operates the power-control relay at the next closure of the contacts of the carrier-operated relay. The power-control relay operates the power-lock-up relay, causing these relays to lock up under each other's control and release the signaling tone. To stop the test tone after commercial power has been restored, the emergency power-signal key at the central office is released. Release of this key restores the normal negative-grounded battery to the signaling circuit. At the next closure of the contacts of the carrier-operated relay, the current through the primary winding of the power-control relay is large enough to overcome the effect of the holding current in the secondary winding, so that this relay releases, and releases the power-lock-up relay to restore the circuit to its normal operating condition.

These circuits are typical of the various arrangements that can be provided for controlling radio equipment over a connecting voice-frequency line. The particular form they take is dictated for the most part by the number and type of operations that these circuits are required to perform.



## Contributors to this Issue

EUGENE PETERSON received the degree of electrical engineer from the Polytechnic Institute of Brooklyn in 1917, and degrees of A.M. and Ph.D. from Columbia in 1923 and 1926. He joined the Western Electric Company in 1919, after two years in the Signal Corps. As circuit research engineer, he is engaged in studies of carrier systems and non-linear circuits.

M. S. HAWLEY received the B.S. degree in electrical engineering from Union College in 1929 and in the fall of that year joined the Laboratories. As a member of the Transmission Instrument Development Department he has been chiefly concerned with the development of telephone receivers of various types, such as the handset receiver, the operator's headset receiver, and those used in aircraft work and with the audiphone. He has also contributed to the development of moving-coil microphones. At

the present time he is engaged in fundamental receiver studies.

J. C. GABRIEL received the E.E. degree from Columbia University in 1917, and then joined the Engineering Department of the Western Electric Company. During the war period he worked on the development of radio equipment for submarine chasers and aircraft. Since then he has been engaged continuously in general radio research and on the various radio developments for the American Telephone and Telegraph Company. These projects include both long-wave and short-wave transatlantic, ship-to-shore, the Green Harbor to Provincetown link, single sideband reception, and the musa.

M. C. BISKEBORN joined the Technical Staff of the Laboratories in 1930 immediately after graduating from the South Dakota State School of Mines with a B.S. degree in E.E. As a



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member of the Outside Plant Department, he has been chiefly concerned with design and development work on carrier cables of various types, such as coaxial, balanced pair, type-K, and cables incidental to the type-J system. He has also been engaged in the development of testing methods for the determination of the electrical characteristics of cable circuits at carrier frequencies.

**C. B. McKennie** spent five years with the F. A.

D. Andrea Company engaged in the design of radio equipment, and then joined the Technical Staff of the Laboratories. In the Radio Development Department he has been continuously engaged in the electrical design of radio equipment. He has worked on the development of aircraft receivers, direction finders, and receivers for ship-to-shore service.

**R. A. Cushman** joined the Laboratories in 1929 following a five-year period at the University of Nebraska where he had been Assistant Professor in Electrical Engineering. Previous to that time he had two years of sales engineering experience and a year of teaching at Cornell University, where he was granted M.E. and

M.S. degrees. In the Radio Development Department he spent eight years in the design of transatlantic radio and high-power broadcasting equipment. For nearly two years he has been in charge of a group designing recording and reproducing equipment and systems in the Commercial Products Development Department.

**H. M. Pruden** joined the Engineering Department of the Western Electric Company during the summer of 1919 and en-

gaged in laboratory work on voice-frequency signaling. As a member of the Technical Staff since 1924, he has been engaged in development of voice frequency signaling and dialing systems, and of voice-operated switching devices and control circuits for radio systems.

**W. Bennett** joined the Laboratories in 1920 and associated with the circuit laboratory, where he engaged in the testing of step-by-step circuits. During this period he studied at Brooklyn Polytechnic Institute in the evenings. Since 1931 he has been a member of the group engaged in the analysis of special central-office system requirements, and in undertaking the necessary circuit design.



*W. Bennett*